POWER

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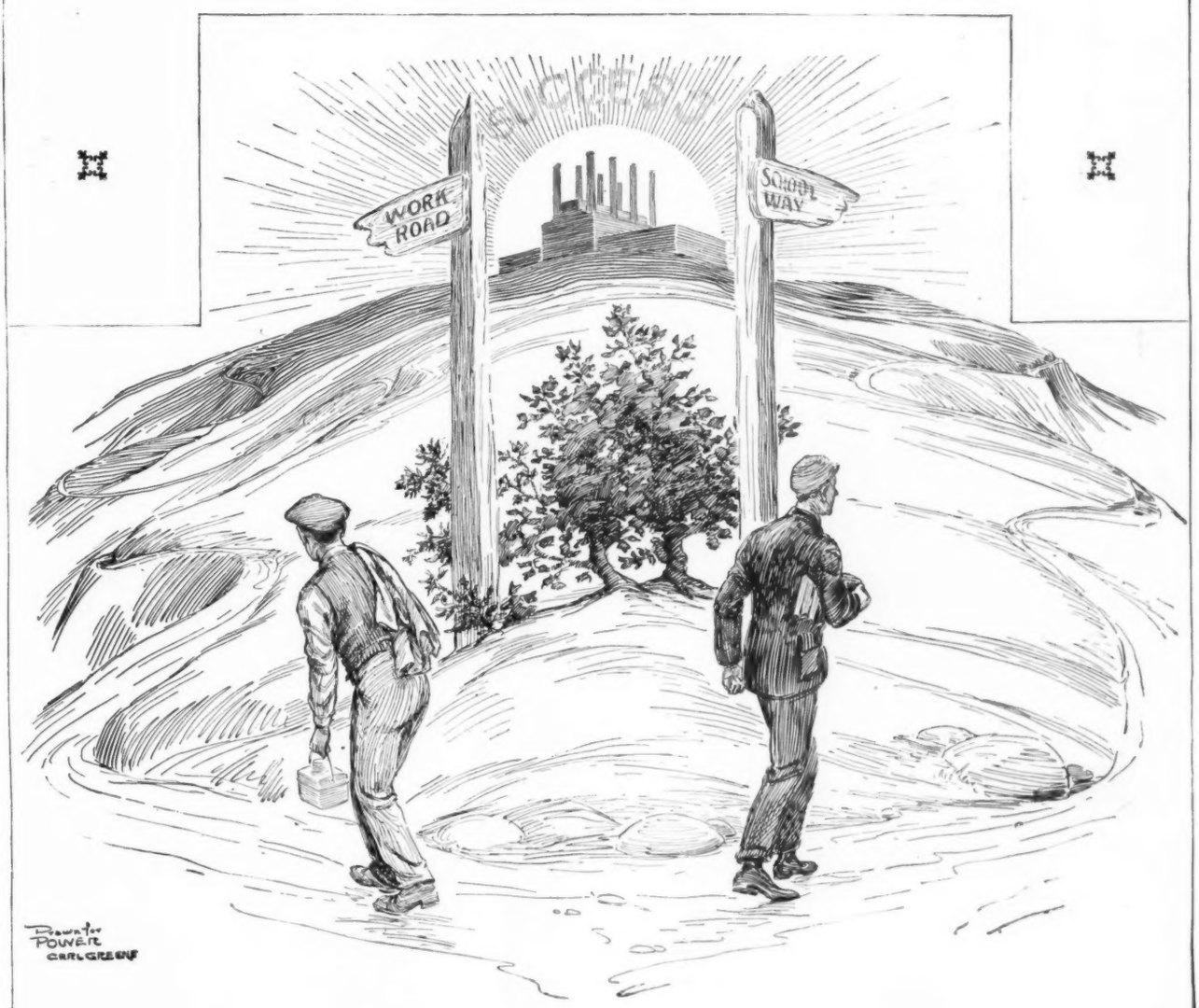
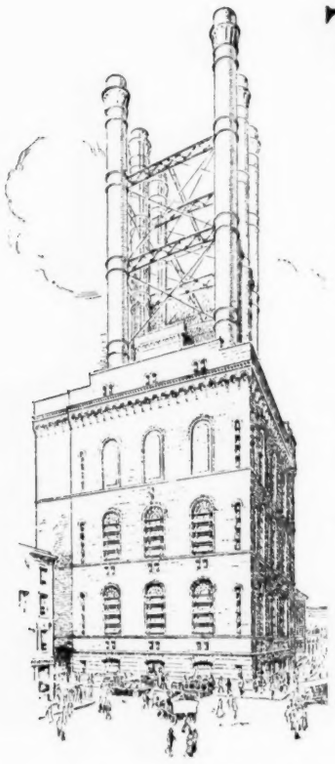
TWO ROADS



Reaching Success Depends on the Stuff in the Man More Than on the Route He Takes.

New High-Pressure Central Steam Plant

By Claude Hartford



THE New York Steam Co., the largest central-station steam company in the country, distributes steam for power and heating purposes through the metropolitan section from several stations. In the down-town district of New York steam has been delivered for the last 35 years from Station B, which has a capacity of 16,000 boiler horsepower. Uptown, Station J, of 19,000 boiler horsepower, supplies the section bounded by 47th St., 74th St., the East River and 7th Ave., which includes perhaps the most exclusive residential section in the world. Owing to the increased demand upon Station B and to its limited facilities, it was decided to build an additional station. Accordingly, a site 107x116 ft. was secured at Burling Slip, from Water to Pearl St., and on part of this plot has recently been constructed Station A,[1] leaving the remainder of the plot for future extensions. The concentration of a maximum output in the space available, due to the high cost of land, and a desire to reduce the operating costs to a minimum were the predominating influences in determining the layout of the new station.

Stations A and B serve the lower part of Manhattan from Duane St. to the Battery and from the East River to the North River, which includes the great financial district. The steam is delivered for power purposes to a large number of office buildings and factories, thus eliminating the necessity for boilers by delivering direct to the engines and also to hydraulic pumps for elevators, house, refrigeration, fire and heating-system pumps. Steam for all purposes is delivered in this district at 100 lb. and, when used for heating only, is reduced at the service to 10 lb. With the new station the pressure is to be raised to 125 lb. Of course, in the down-town district the steam is generally used to generate power and the exhaust for heating. In the up-town section the greater part of the load is for heating.

Work was started on the new plant last spring, the foundation completed by July 1, and steam delivered from the station to the system on Dec. 1. Fig. 2 shows a second-floor boiler header waiting for the steelwork in order to be slung into place, which indicates how the early completion of the plant was accomplished.

Owing to the tidewater and subsurface conditions, the building is really on a floating foundation. An interlocked steel sheathing was first driven around the edge of the plot, and then, after excavation, a mat 6 ft. thick of steel-reinforced concrete was laid over the entire plot. On this mat the foundations were constructed of concrete heavily reinforced with steel. The outer walls are of colonial brick faced with granite, giving a very attractive appearance. While there are only four stories, the building is equivalent in height to a ten-story structure. The six steel, brick-lined stacks (one for each two boilers) extend 300 ft. from the ground, or 175 ft. above the roof of the building.

The general layout is shown in the cross-sectional view of the station, Fig. 3. The ground floor is given up to the station auxiliaries, including boiler-feed pumps, service pumps, blowers, etc. The boiler-feed pumps, five in number, are Jeanesville centrifugal, direct-connected to 120-hp. Kerr turbines and are rated at 500 gal. per min. each. The three service pumps are American single steam pumps rated at 700 gal. per min.

[1]Built and operated by New York City District Realty Co.

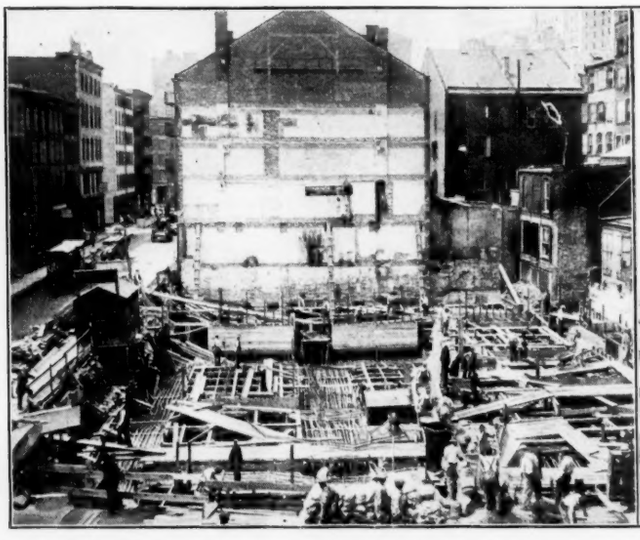


FIG. 1. SHOWING FOUNDATION WORK

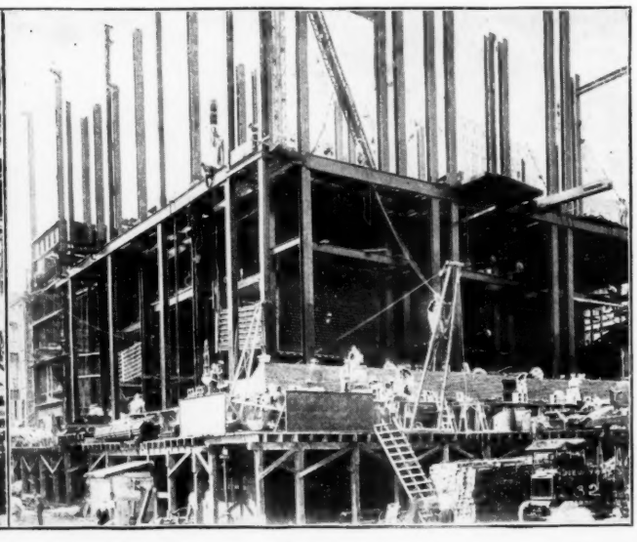


FIG. 2. BOILERS BEING INSTALLED

There are five improved Green blowers for the forced-draft system, turbine-driven and rated at 100,000 cu.ft. of air per minute each. Electricity for light and station power is furnished by two 100-kw. Crocker-Wheeler direct-current generators driven by Kerr turbines. The auxiliaries require about 1500 boiler horsepower when the station is operating at maximum capacity.

The first floor has six boilers, three on either side of the firing aisle, which runs east and west. These are rated at 1000 hp. each, but will be operated at 200 per cent. capacity, or 2000 hp. They are Edge Moor type with dutch-oven furnaces and three vertical passes

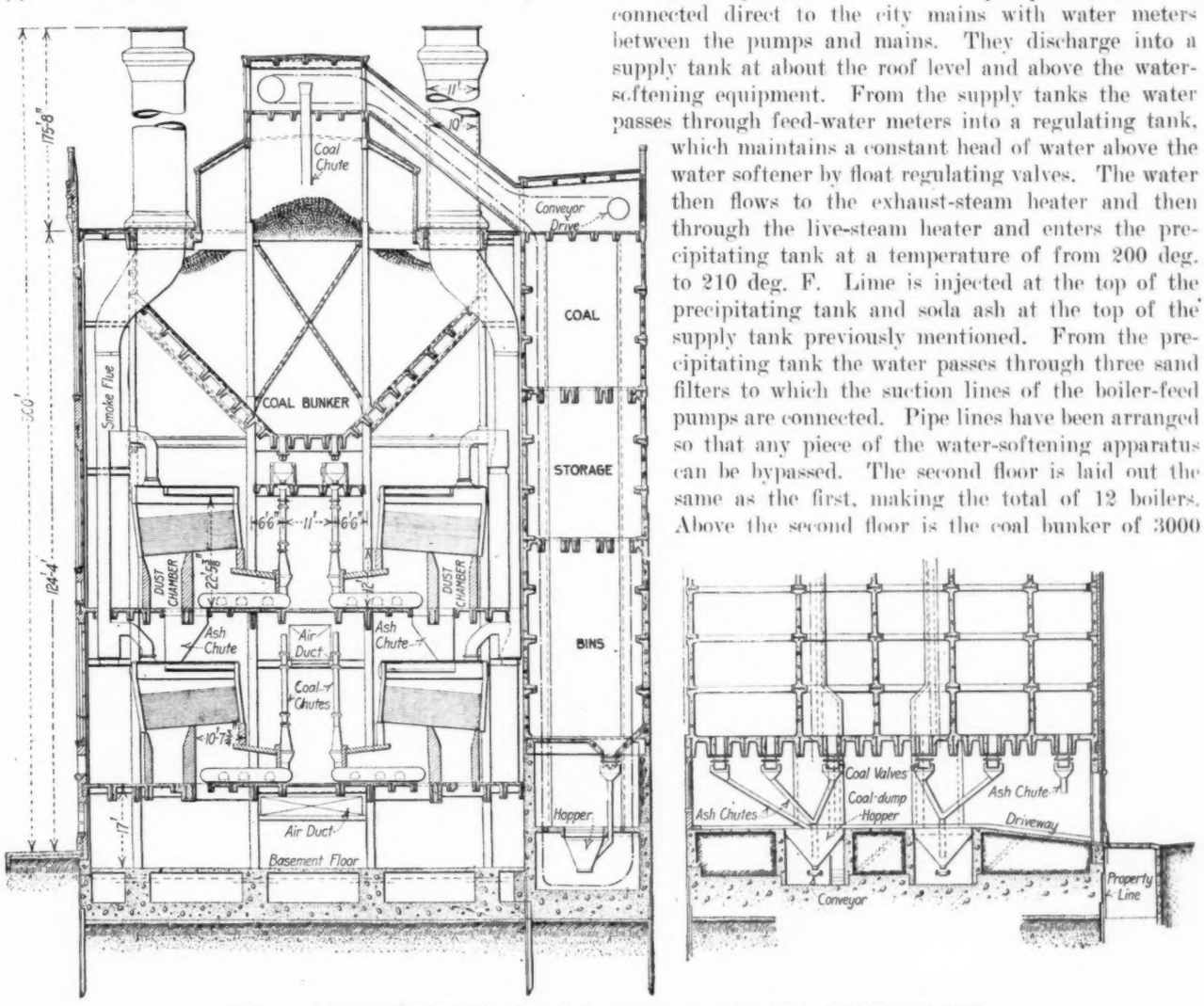


FIG. 3. SECTIONS THROUGH PLANT, SHOWING GENERAL ARRANGEMENT

through the tubes. Automatic stokers of the Cox traveling-grate type make possible the burning of the smallest size of anthracite. There are two draft boxes beneath each boiler, each box divided transversely into four parts, thereby giving opportunity for the requisite draft regulation for maximum combustion of the fuel on the moving grate. The combustion at each step in grate travel is observed and the draft at each section adjusted to the combustion conditions at that point. The stokers are motor-operated through a system of worm gears. From the rear of the stoker grate the ashes fall directly into a moving bucket conveyor which delivers into a wetting hopper, from which the ashes are discharged by means of a moving cast-iron drag chain into the main ash conveyor; the latter elevates the ashes to the main ash-storage bin of 1000 cu.yd. capacity. The ash-conveying system is in duplicate to prevent any delay in operation due to repairs, etc. The waste gases from the boilers are passed through cinder catchers, one for each boiler, before going to the stacks. These catchers consist of adjustable baffles which deflect the gases over a trough of water. By adjusting the baffles the velocity of the gases is varied and the amount of cinder precipitation controlled.

The city water, used for boiler feed, is treated by the Vater process. The service-pump suctions are connected direct to the city mains with water meters between the pumps and mains. They discharge into a supply tank at about the roof level and above the water-softening equipment. From the supply tanks the water passes through feed-water meters into a regulating tank, which maintains a constant head of water above the water softener by float regulating valves. The water then flows to the exhaust-steam heater and then through the live-steam heater and enters the precipitating tank at a temperature of from 200 deg. to 210 deg. F. Lime is injected at the top of the precipitating tank and soda ash at the top of the supply tank previously mentioned. From the precipitating tank the water passes through three sand filters to which the suction lines of the boiler-feed pumps are connected. Pipe lines have been arranged so that any piece of the water-softening apparatus can be bypassed. The second floor is laid out the same as the first, making the total of 12 boilers. Above the second floor is the coal bunker of 3000 tons' capacity. At the south end of the building are the storage bunkers, with a capacity of 5000 tons, and also the ash bunkers previously referred to.

It was found impossible to secure a site for the plant on the river front, which would be the best location from the transportation of fuel standpoint. Therefore, fuel is delivered to the station by six-ton auto trucks which means has proved very satisfactory, especially over the old method of supplying coal to Station B by horse-drawn trucks. The fuel is dumped on conveyors and carried to the top of the plant, where it is distributed either to the main bunker or to the storage bunker, as desired. The coal-conveying apparatus is all installed in duplicate. At specified times the delivery

truck after dumping its load of coal, receives a load of ashes from the ash bins by chute directly overhead.

About 900 tons of coal is consumed per day by this plant. The fuel from the main bunker passes through weighing scales to each boiler hopper. All scales are attended by one man, and an electric signal system has been installed which notifies the operator whenever one of the scales is empty. Sufficient scientific apparatus is installed to give complete detail for checking the efficiency of the individual boiler or the entire plant. The stoker operation requires two men per floor per shift of eight hours. Each boiler is equipped with a Bailey boiler meter, which indicates to the firemen the exact furnace conditions at all times, these conditions being set for maximum efficiency. The operation of the plant under maximum conditions will require thirty men, which is a saving of 75 per cent. over the methods in the old station.

FIG. 5. SECTIONS SHOWING DISTRIBUTION MAINS

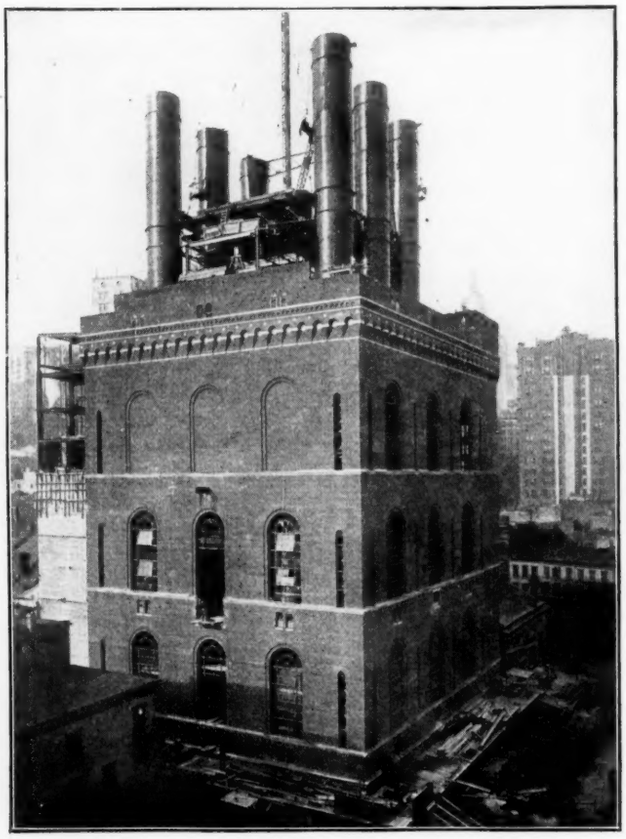


FIG. 4. PLANT NEARING COMPLETION, STACKS PARTLY UP

All piping is of the extra-heavy A. S. M. E. standard, and all main steam and auxiliary piping, feed-water and blowoff piping has welded flanges.

Fig. 5 shows the cross and longitudinal sections of a standard main. In laying a main a trench is first dug. The proper levels are taken with a transit, and the bottom of the trench is concreted to a depth of 5 in., reinforced with steel rods; at anchored fittings the thickness is 7 in. In this manner the construction is made self-sustaining. The saddles for the main are grouted to the concrete base, and the fittings are either anchored to the base or floating, as required. The Badger expansion joint is used, being of the copper double-corrugated type. All pipe and fittings of the distribution system are extra-heavy A. S. M. E. standard, with welded flanges. As shown in Fig. 5, multi-cell construction is used, composed of hollow-tile duct, each length being sealed, and is laid on the concrete base to the level of the center of the pipe and half of a sewer tile grouted to either wall. The same idea is followed in laying service pipes. The mains range from 3 to 24 in. in diameter. The pipe is covered with 3 in. of "dabonite" (an asbestos covering) secured with staples and around this insulation is placed a double covering of rubberoid roofing. The joints of the sections are staggered and are sealed with mastic cement. Then a heavy coating of a waterproof electrolytic paint is applied.

Among the larger power consumers are the Mutual Life Insurance Company Building, the American Surety Company Building, the Schermerhorn Building, the Jersey Central Railroad Building, ferry and terminal, the Royal Insurance Company Building, the Havemeyer Building, the Liberty Tower Building, the Lords Court Building, the Sevillia Apartment Hotel, The Coronet Apartment Hotel, The Arion Society, Terrace Garden, the Haberman Building, the Bank of America, the National City Bank, the American Exchange National Bank, the New York Clearing House, the Chamber of Commerce, and the New York Post Office. It is not generally known that such buildings have their own plants for the generation of electrical current for both power and light and secure their steam from the street service to drive their engines, but it has been proved both practical and economical. The steam is measured when used for power, just after it enters the building, by St. John meters, which are of the flow type, and by condensation meters of the bucket type when used for heating.

Pointers on Radiator Connections

By W. H. H. Plowman.

Why are the returns of radiators almost always connected into the return line with T's instead of Y's, so that the returns of one radiator are held back by the flow of the adjacent one? Another bad practice is that the inlet is sometimes connected to the bottom of the radiator of a double-pipe system instead of the top, making the inlet do the work of a one-pipe system; besides, it collects dirt and scale on its seat and prevents it closing tight.

Another bad feature is to put the return check valve on the same level as the radiator. Always lower it at least four inches, so that the weight of the water above it will overcome the back pressure and allow the check to balance when the pressure is equal. If there is no room between the radiator and the floor to lower the check, then raise the radiator to the desired height. These remedies will do way with the annoyance of pounding.

Diversity and Diversity Factors*

By Terrell Croft

SYNOPSIS—The various elements that determine the diversity factor among consumers, transformers, feeders, substations, from consumer to transformer, consumer to feeder, consumer to substation and consumer to generator are considered, with explanatory examples.

In central-station parlance the term diversity is used to signify diversity of demand—to imply that the maximum demands of the various consumers of different classes and of the different circuit elements occur at different times. It is obvious that the residence-lighting load will attain its maximum in the evening, whereas a manufacturing establishment will ordinarily require the greatest power during the daylight hours. Again, commercial establishments of certain types—for example, department stores—generally use much more power during the day than in the evening, while stores of other sorts, such as drug stores, use more in the evening. A similar condition holds for the different sorts of manufacturing establishments. Hence, there is a diversity of demand among these different classes of central-station load. Fig. 1 illustrates the general idea graphically. It shows typical power- and lighting-load curves for an average city and also indicates the total-load curve, which is obtained by adding together those for the power and the lighting loads. It will be noticed that the power-load peak and the lighting-load peak do not occur at the same time; that is, there is a diversity between their maximum demands.

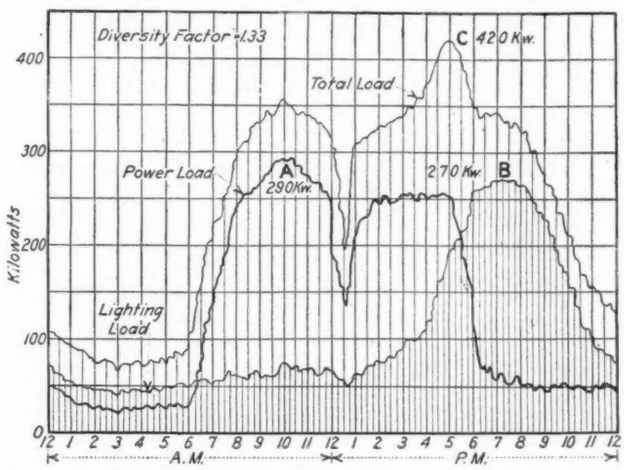


FIG. 1. CURVES SHOWING DIVERSITY BETWEEN POWER AND LIGHTING LOADS

It follows that the maximum demand on a transformer is less than the sum of the maximum demands of the consumers served from that transformer. Also, the maximum demand imposed on a feeder is less than the sum of the maximum demands of the transformers fed from the feeder, and the maximum demand on the generating station is less than the sum of the maximum demands of the feeders supplied from the station.

A graphic illustration of diversity of demand is given in Fig. 2, which was constructed from data obtained from a study of diversity, discussed by Samuel Insull in a paper, "Centralization of Energy Supply," delivered before the Finance Forum of the New York Y. M. C. A. on Apr. 20, 1914. For the purposes of this study 82 consumers were classed into 11 groups. The maximum demand of each of the 11 groups occurring during a certain year was ascertained with maximum-demand meters. The total area of each of the rectangles 1 to 11, in the diagram, is proportional to the maximum demand of the corresponding group of consumers. The combined maximum demand for all the 82 consumers was 9770 kw., and it occurred about 5 p.m. in December. At the same hour at which this 9770 kw. was imposed on the central station the maximum demands of the different groups were proportional to the shaded areas in the small rectangles. It will be noticed that consumers of certain classes—such as the brickyards, quarries, ice manufacturers and cement works—imposed practically no demand on the system at this time.

The importance of diversity of demand can be appreciated if one considers the increase in generating- and distributing-plant capacity that would be necessary if the maximum demands of all consumers occurred simultaneously. It is of concern to the engineer—because a designer should consider it in planning the generating and substations and the distribution system. Diversity is an element in the determination of rates for electric service. If it were not for the fact that the combined maximum demand imposed on an average central sta-

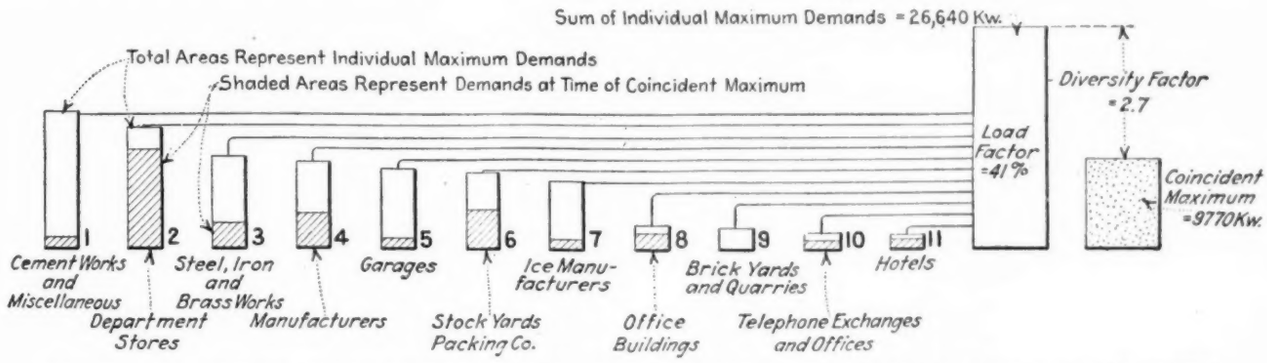

Sum of Individual Maximum Demands = 26,640 Kw.
Total Areas Represent Individual Maximum Demands
Shaded Areas Represent Demands at Time of Coincident Maximum
Diversity Factor = 2.7
Load Factor = 41%
Coincident Maximum = 9770 Kw.
1 Cement Works and Miscellaneous
2 Department Stores
3 Steel, Iron and Brass Works
4 Manufacturers
5 Garages
6 Stock Yards Packing Co.
7 Ice Manufacturers
8 Office Buildings
9 Brick Yards and Quarries
10 Telephone Exchanges and Offices
11 Hotels

FIG. 2. INDICATES GRAPHICALLY THE DIVERSITY FACTOR FOR 82 LARGE LIGHT AND POWER CONSUMERS

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tion is usually considerably less than half of the sum of the maximum demands of all the consumers. the investment involved to provide electric service would be very much greater than that which is now required. If it were necessary to increase the investment thus, the cost of service would have to be increased accordingly.

The diversity factor of a system may be defined as the ratio of the sum of the individual maximum demands of a number of loads during a specified period to the simultaneous maximum demand of all these same loads

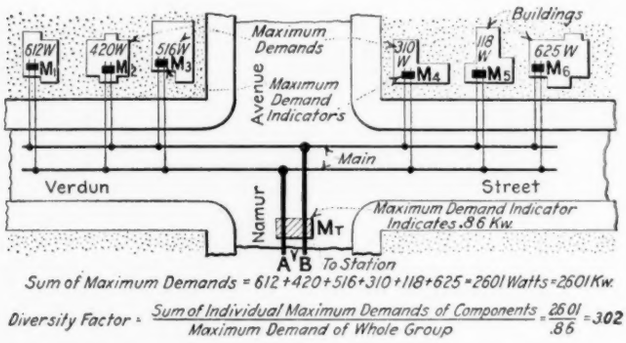


FIG. 3. ILLUSTRATING THE MEANING AND COMPUTATION OF DIVERSITY FACTOR

during the same period. If all the loads in a group impose their maximum demands at the same time, then the diversity factor of that group will be 1.

Consider two consumers each of which has a maximum demand of 100 kw. The sum of their individual maximum demands would then be 200 kw.; but if a maximum-demand meter in the circuit supplying these two

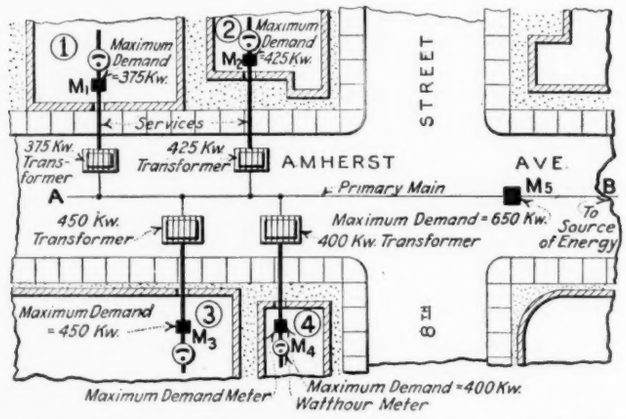


FIG. 4. LAYOUT OF THE LOAD CURVES OF WHICH ARE GIVEN IN FIG. 5

consumers indicated only 150 kw., as it might if the individual demands of the two consumers did not occur at the same time, the diversity factor between these two consumers would then be 200 kw. ÷ 150 kw. = 1.33. It follows then that:

$$\textit{Diversity factor} = \frac{\textit{sum of individual maximum demands}}{\textit{maximum demand of entire group}} \quad (1)$$

$$\textit{Sum of individual maximum demands} = \textit{diversity factor} \times \textit{maximum demand of entire group} \quad (2)$$

$$\textit{Maximum demand of entire group} = \frac{\textit{sum of individual maximum demands}}{\textit{diversity factor}} \quad (3)$$

A diversity factor is sometimes given as the reciprocal of the value obtained from the above equations. However, equation (1) is in accord with the A. I. E. E. Standardization Rules, Section 60, hence is utilized herein.

In Fig. 3 the sum of the individual maximum demands of the six component loads, as observed from the maximum-demand indicators M_1, M_2, etc., is 612 + 420 + 516 + 310 + 118 + 625 = 2601 watts = 2.601 kw. The maximum demand of the whole group as indicated on the maximum-demand indicator M_T is only 0.86 kw., because the maximum demands of the consumers did not all occur at the same time. Then:

$$\textit{Diversity factor} = \frac{2.601}{0.86} = 3.02$$

Therefore, the diversity factor among the six consumers and the supply main AB, Fig. 3, is 3.02.

The maximum demand of the power load A, Fig. 1, during the 24-hr. period shown, is 290 kw. The maximum demand of the lighting load B is 270 kw. But the maximum demand of the combined loads is, as shown at C, about 420 kw. What is the diversity factor for these loads?

Diversity factor = sum of individual maximum demands ÷ maximum demand of entire group = (290 + 270) ÷ 420 = 560 ÷ 420 = 1.33

Hence, the diversity factor in this case is 1.33.

Fig. 4 shows an imaginary case where four consumers 1, 2, 3 and 4 are supplied with electric service from the primary main AB through four transformers. The load curve for each of these four consumers is given in Fig. 5, from which it is evident that their maximum demands are respectively 375, 425, 450 and 400 kw.; the maximum-demand indicators M_1, M_2, M_3 and M_4 would respectively indicate these individual maximum demands.

From Fig. 6, in which are graphically added the graphs 1, 2, 3 and 4 in Fig. 5, it is evident that, because of the diversity in the individual demands, the maximum demand of the entire group is only 650 kw. If a maximum-demand indicator M_5, Fig. 4, was inserted in the primary main, it would, for the period under consideration, read 650 kw. Then the diversity factor of these four consumers would be:

$$\textit{Diversity factor} = \frac{\textit{sum of individual maximum demands}}{\textit{maximum demand of entire group}} = \frac{375 + 425 + 450 + 400}{650} = 2.54$$

Notice that while the transformers to serve the four loads shown would have to be about the capacities indicated in Fig. 4 to prevent overloading, the group of consumers would impose a maximum demand of only 650 kw. on the source of energy.

To determine diversity factors it is necessary for most accurate results, to use maximum-demand indicators on the service conductors of each consumer involved in the study. Frequently, maximum ammeters are used on the consumers' services in studies of this sort. Then, to obtain the equivalent watts demand, the maximum-ampere demand imposed is multiplied by the normal voltage of the circuit, it being assumed that this voltage remains constant. H. B. Gear, of the Chicago Edison Co., has made important studies of diversity, some of which are outlined in detail in his book, "Electric Central-Station Systems." Most of the demand-factor values recited herein are based on his observations.

There may be several different diversity factors applying to the components of a generation and distribution system, as illustrated in Fig. 7 and in Table 1. Thus, there may be a factor indicating:

1. The diversity among the demands of the different consumers.
2. The diversity among the demands of the transformers in a group.
3. The diversity among the demands imposed by the different feeders on a substation.
4. The diversity among the demands imposed by the different substations on the generating station that serves them.
5. The diversity among the demands of the different classes of consumers, as shown in Fig. 2.

Diversity-factor values are in a measure determined by local conditions. The characteristics and habits of the people in a community will affect the values of the di-

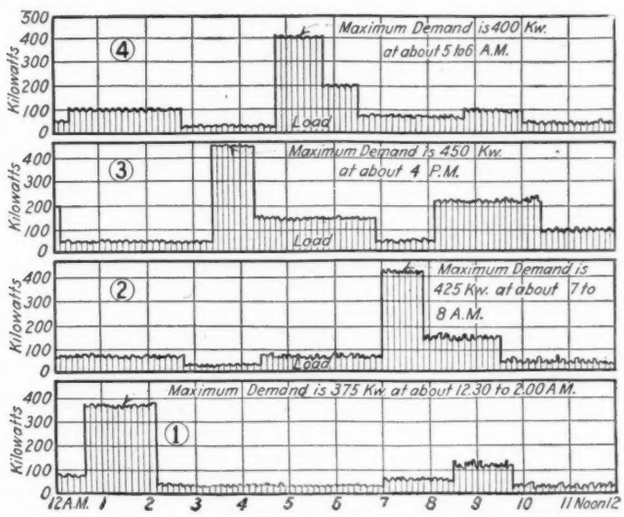

Maximum Demand is 400 Kw. at about 5 to 6 A.M.
Load
Maximum Demand is 450 Kw. at about 4 P.M.
Load
Maximum Demand is 425 Kw. at about 7 to 8 A.M.
Load
Maximum Demand is 375 Kw. at about 12:30 to 2:00 A.M.
Kilowatts
12 A.M. 1 2 3 4 5 6 7 8 9 10 11 Noon 12

FIG. 5. GRAPHS INDICATING THE DEMANDS OF FOUR DIFFERENT IMAGINARY LOADS

versity factors applying to it. In a rural city the diversity factors will be somewhat different than in a metropolis. Where the power load preponderates over the lighting, the overall diversity factor will be different than where the opposite condition holds. Furthermore, the values of the diversity factors among certain of the components of a system may be determined in a measure by the layout of the system itself, as explained in a following paragraph under residence-lighting transformers. Hence, it is obvious that it is practically impossible to predict with accuracy the diversity factor that will apply for a given set of conditions unless one is already familiar with the diversity factor that has been ascertained by observation and test for like conditions. However, the factors that are suggested below and given in

TABLE 1. DIVERSITY FACTORS AMONG THE DIFFERENT ELEMENTS OF A CENTRAL-STATION DISTRIBUTING SYSTEM

	Diversity Factors			
Elements of Distribution System	Residence Lighting	Commercial Lighting	General Power	Large Users
A. Among consumers	3.36	1.46	1.44	
B. Among transformers	1.30	1.30	1.35	1.15
C. Among feeders	1.15	1.15	1.15	1.15
D. Among substations	1.1	1.1	1.1	1.1
E. Consumer to transformer	3.36	1.46	1.44	
F. Consumer to feeder	4.35	1.91	1.95	1.15
G. Consumer to substation	5.00	2.19	2.24	1.32
H. Consumer to generator	5.53	2.41	2.45	1.45

Table 1 are probably fairly typical. They may ordinarily be used without great error in estimating situations similar to those to which they apply specifically.

The data in Table 1 are based on observations made in Chicago, as presented by H. B. Gear in the "Standard Handbook." The reference letters A, B, C, etc., in the first column refer to Fig. 7.

The diversity of demand among residence-lighting consumers is usually, where a dozen or so consumers are involved, represented by a factor of about 3.4. In one block in Chicago, which was supplied by a single transformer and in which there were 34 consumers, it was found that the sum of the consumers' maximum de-

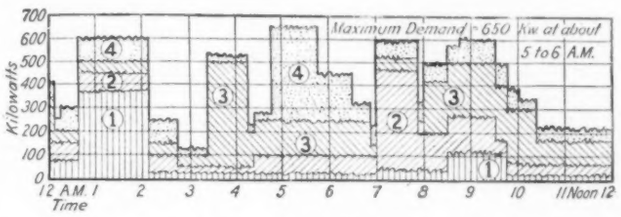


FIG. 6. COMBINED CURVE OF LOADS IN FIG. 5

mands was 12 kw., while the maximum demand of the group was 3.6 kw. This gave a diversity factor of 12 ÷ 3.6 = 3.33. In another block, where there were 185 consumers, the total of the individual consumers' maximum demands was 68 kw. The maximum demand imposed on the transformer serving the block was 20 kw. Hence, the diversity among these consumers was 68 ÷ 20 = 3.40. The factor indicating the diversity among the demands of residence consumers is much greater than that among general power consumers (see the values given in Fig. 7 and Table 1).

The diversity among the demands of commercial-lighting consumers is not, experience shows, nearly so pronounced as with residences. The reason for this is that

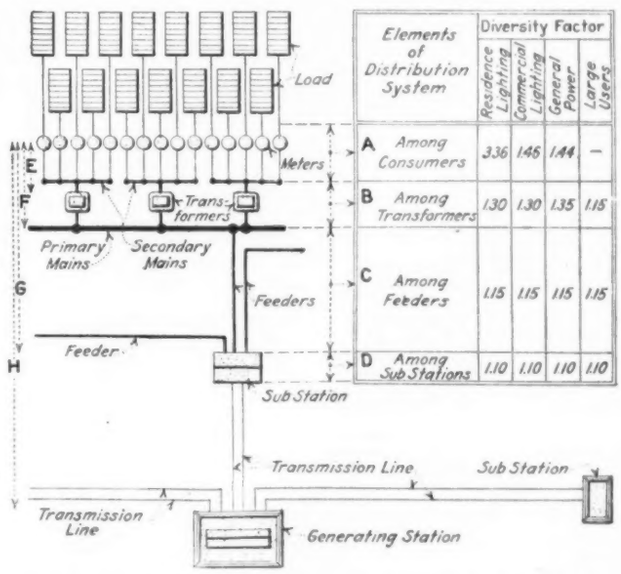


FIG. 7. DIVERSITY OF DEMAND AMONG DIFFERENT COMPONENTS OF A DISTRIBUTION SYSTEM

commercial lighting in factories and stores is ordinarily used at about the same hours in the day and about the same days in the week by one business concern as by another. The result is that the diversity factor among a number of these consumers is usually relatively low, possibly in the neighborhood of 1.4. That the factor is this large is because some commercial consumers—department stores, for instance—use most of the light in

the late afternoon or early in the evening, while other concerns—hotels, for example—use most of their light in the evenings (see Fig. 7 and Table 1).

The diversity among demands imposed on the mains by lighting transformers for residence and commercial service may, for well-designed distribution systems, be represented probably by an average factor of from 1.3 to 1.35. If a large number of small transformers are used to serve a load, instead of a few large ones, the resulting diversity factor among the transformers imposed on the mains will probably be greater than 1.3. The reason for this is that if a large number of small transformers are installed, the sum of their individual maximum demands will be greater than the sum of the individual demands of a few large transformers serving the same load, the combined maximum demand of the group being the same in each case. The following example illustrates this principle:

Consider the imaginary condition illustrated in Fig. 8, where there are 20 consumers, each having a maximum demand of 1 kw., as indicated by the maximum-demand meters M_1. Assume that the maximum demand of the

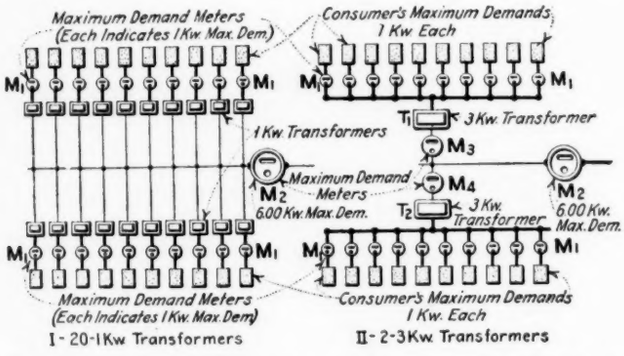


FIG. 8. HOW DIVERSITY FACTOR BETWEEN TRANSFORMERS MAY VARY WITH LOAD ARRANGEMENT

group of 20 consumers is 6 kw., as indicated by meters M_2. Then, if twenty 1-kw. transformers are used to serve the load, as at I, the diversity factor between the transformers and the mains is 20 kw. ÷ 6 kw. = 3.33.

Assume that these 20 customers are to be served by only two transformers, each feeding 10 consumers, as at II. Also assume that the same diversity factor, 3.33, would obtain among the consumers. Then the maximum demand imposed by transformers T_1 and T_2 would be in each case 10 kw. ÷ 3.33 = 3 kw. The sum of their maximum demands would be 3 + 3 = 6 kw. Hence, the diversity factor between these two transformers and the mains would be 6 kw. ÷ 6 kw. = 1. These conditions are obviously imaginary, but the example indicates how diversity is determined to some extent by the arrangement and capacities of the component equipment.

Observe in the example just given the economy in transformer capacity resulting from the grouping of a relatively large number of consumers on one transformer. In case I twenty 1-kw. transformers are required, while in case II two 3-kw. transformers will handle the load.

W. T. Ryan reports that he found that the average diversity factor among residence-lighting transformers in a number of Minnesota cities was 1.6. He attributes this rather high value to the fact that probably an unnecessarily large number of small transformers were used in the cities investigated.

To determine the maximum demand that will be imposed on any transformer, feeder or station when the connected load, demand and diversity factors are known: Multiply the connected load by the demand factor and divide the product by the diversity factor. That is:

$$\textit{Maximum demand of entire group} = \frac{\textit{connected load} \times \textit{demand factor}}{\textit{diversity factor}} \qquad (4)$$

Consider the conditions of Fig. 9, wherein 36 residence-lighting consumers are shown. The connected load of each consumer in watts is indicated at each building. If it is decided to serve these consumers with three transformers A, B and C, what should the capacities of these transformers be and what will be the maximum demand imposed on the primary main at D? It will be assumed that the consumers' demand factor is 0.50, that the diversity factor among these consumers is 3.35 and that the diversity factor among transformers is 1.3.

The connected load of group A is 1420 + 670 + 480 + 1510 + 600 + 1310 + 1480 + 515 + 910 + 680 + 1460 + 2520 = 13,555 watts = 13.6 kw. Then substituting in equation (4):

$$\textit{Maximum demand of entire group} = \frac{\textit{connected load} \times \textit{demand factor}}{\textit{diversity factor}} = \frac{13.6 \times 0.5}{3.35} = 2\ \textit{kw.}$$

Therefore, a 2-kv.-a. transformer could be used at A.

The connected load of group B is 1630 + 1420 + 1460 + 1510 + 450 + 550 + 1500 + 940 + 1500 + 420 + 1310 + 960 + 2560 + 420 + 1380 = 18,010 watts = 18 kw. Then:

$$\textit{Maximum demand of entire group} = \frac{18 \times 0.5}{3.35} = 2.7\ \textit{kw.}$$

Therefore, a 3-kv.-a. transformer could be used at B.

The connected load of group C is 550 + 1460 + 2210 + 1580 + 320 + 2560 + 2400 + 1610 + 1240 = 13,930 watts = 13.9 kw. Hence, in this case:

$$\textit{Maximum demand of entire group} = \frac{13.9 \times 0.5}{3.35} = 2.1\ \textit{kw.}$$

Therefore, a 2 kv.-a. transformer would probably suffice at C.

To find the maximum demand imposed on primary main D, substitute in equation (3):

$$\textit{Maximum demand of entire group} = \frac{2.0 + 2.7 + 2.1}{1.3} = \frac{6.8}{1.3} = 5.2\ \textit{kw.}$$

Therefore, 5.2 kw. would be the maximum demand on the primary main at D. In actual practice it would probably be desirable to serve all the consumers shown in Fig. 9 by installing one larger transformer instead of using three relatively small ones, as shown. However, the example illustrates the principle involved.

To utilize the principle of diversity of demand among lighting consumers most effectively—that is, to insure a maximum diversity factor—there should usually be a minimum of from 8 to 12 consumers served from each distributing transformer.

The diversity of the demands among feeders appears to range in the neighborhood of about 1.15 in a well-designed system. In other words, the maximum demands on feeders usually occur almost simultaneously.

If a generating station serves two feeders, one of which imposes a maximum demand of 650 kw. and the other

a maximum demand of 485 kw., what will be the maximum demand that the two will impose on the station, it being assumed that the diversity factor for these feeders is 1.15?

$$\textit{Maximum demand of entire group} = \frac{\textit{sum of individual maximum demand}}{\textit{diversity factor}} = \frac{650 + 485}{1.15} =$$

$$\frac{1{,}135}{1.15} = 988 \textit{ kw.}$$

Therefore, the maximum demand that these two feeders would impose on the station would be 988 kw.

There is a diversity among the demands of different substations, where such form a part of a distribution system. The value of the factor representing this diversity will obviously be determined by the characteristics of the territory served by the substation. If one substation serves a residence district and another a factory district, the diversity factor is likely to be large. On the other hand, the diversity factor among the demands would probably be imposed by them on the generating equipment. Mr. Gear states that the total diversity factor in the Chicago system for the lighting and power load, but not including electric railways, is 3.2 during the winter months.

To determine the kilowatt station capacity required per 100 kw. connected load, divide the consumer's demand factor, expressed as a percentage, by the total diversity factor.

If the total diversity factor for a residence-lighting load is 5.53 and the demand factor is 75 per cent., what kilowatt station capacity will be required per 100 kw. of lighting load? Solving, $75 \div 5.53 = 13.6$. Hence, about 13.6 kw. station capacity would be required, under these conditions, per 100 kw. connected residence-lighting load.

By the foregoing outlined process it can be shown that, for commercial-lighting loads, about 37 kw. station capacity is necessary per 100 kw. connected; and for general power loads, about 40 kw. per 100 kw. connected.

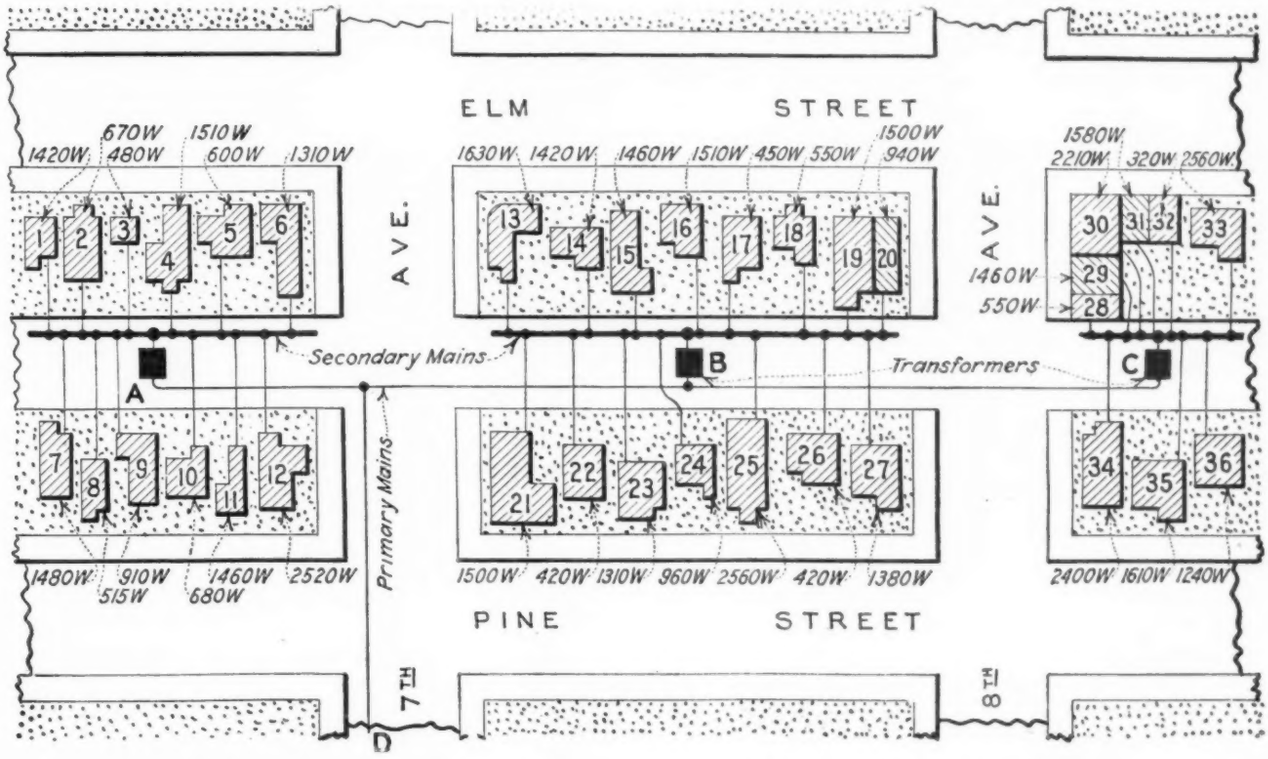


FIG. 9. GROUP OF THIRTY-SIX RESIDENCES SERVED FROM THREE TRANSFORMERS

of two substations both serving manufacturing communities, or any two communities of similar characteristics, is apt to be small—that is, in the neighborhood of 1.

The total diversity factor for a system is equal to the product of the diversity factors of all the components of the system.

What is the total diversity factor for the residence-lighting load of a system where the component diversity factors are (see Table 1) as follows: Among consumers, 3.36; among transformers, 1.30; among feeders, 1.15; among substations, 1.1? The product of these factors is $3.36 \times 1.30 \times 1.15 \times 1.11 = 5.53$. That is, 5.53 is the total diversity factor (note this value in the first column of Table 1) by which the sum of the individual maximum demands of lighting consumers should be divided to obtain the maximum demand that W. T. Ryan states that in Minneapolis (population 325,000) the ratio of the maximum demand imposed on the station to the total connected load is approximately 1 to 3—that is, 33 kw. station capacity per 100 kw. connected load.

The importance of diversity as a factor in plant design can readily be appreciated from a consideration of the foregoing information. A distributing or generating plant must be designed largely on the basis of the maximum demand that will be imposed on it. Therefore, if the designer of a new installation is familiar with the diversity factors that are likely to obtain for the conditions under which his system will operate, he can readily determine the required capacities for the members of the system by applying suitable demand and diversity values.

A Day with a Gas-Engine Troubleman

By D. L. Fagnan

SYNOPSIS— A good engine suddenly misbehaves; the engineer confesses he is "stumped" and calls in the troubleman. What was wrong and why, and how the engine was made to run well are entertainingly set forth.

The writer as troubleman was to leave the job on hand and hurry to a Texas city to overcome serious trouble with a producer-gas engine which was depended upon to operate the city electric-light and water plant. The engine was a single-cylinder 150-hp. horizontal unit direct-connected to a 125-kw. generator. There also was a two-cylinder vertical engine to take the load from 11 p.m. to 5:30 a.m. The big engine had given good service for many years.

"Well, boy, there's your engine, and here's some tools. Anything you want, call for it," said the engineer when I arrived. He acknowledged he was "licked" by that engine. And he was above the average, too. The manager of the plant welcomed me and said the usual, "You know we look to you for quick results," etc., etc. The engine was carrying about one-third load nicely, and there were no signs of laboring or trouble. First, I suggested that we eat, and while munching I had the engineer describe the trouble.

Engineer Describes the Trouble

"The fuss don't begin until about 4:30 p.m., when the load begins to rise, and then things happen," said he. "She carries light loads nicely, but as the load increases the bombardment is terrific, although the producers give good gas; the moisture admitted to the saturator is all right; the test flame is good and continuous. I've looked for air leaks in the piping and cannot find any. The trouble is in the engine.

"I've examined the valves—inlet and exhaust—looked into the cylinder for projecting parts of metal and for gaskets, for hollow pockets where the gas could accumulate and later ignite the entering charge. Also, I've looked for pieces of metal in the compression space that could possibly remain incandescent during heavy loads and cause preignition or backfiring, whichever it is, but found nothing. It's now up to you."

My first move was to get him to throw off the load temporarily and to slow down the engine, blocking the exhaust valve open so I could attach an indicator cock to the cylinder. This done, we speeded the engine again quickly without having allowed it to stop. The load was immediately thrown on.

Indicator diagrams showed that a leaky exhaust valve was responsible for the trouble, for if the inlet valve leaked it would be sure to make itself known by a wheezing noise when the ear was placed on the inlet air pipe, which leads to the main frame of the engine, where the air inlet is taken from the lower part of the base.

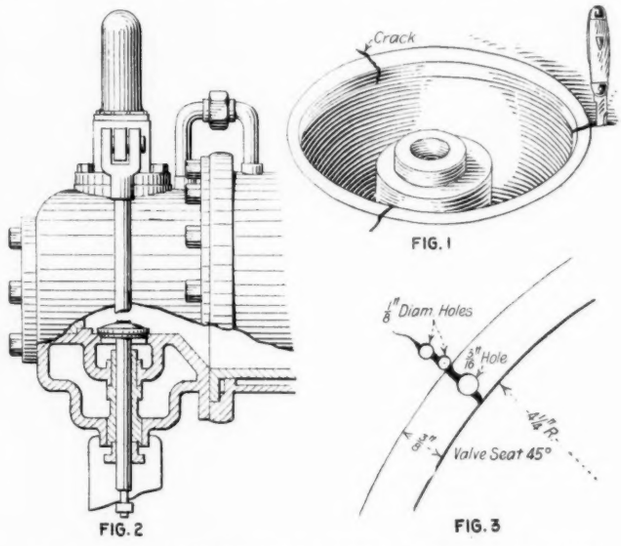
Placing the engineer at the switches and instructing him to pull them when I shut off all gas and while the engine was slowing down, I took two compression diagrams and quickly brought the engine up to speed and closed the switches. We again proved that the exhaust valve was at fault.

"But," said the engineer, "I had it out and it looked all right—no scoring and the seat was clean and tight. Further, the valve seat in the cylinder head seemed to be in good condition."

It was possible to turn the exhaust valve on its seat only about one inch on either side of the present position, owing to the water-cooling attachment, which limited the movement.

Just then a call came to refill the water standpipe for the railroad company, and he started a motor-driven triplex pump which increased the load materially. We now had about half-load, and a slight coughing noise came from the engine. The engineer smiled and said things were going to happen.

Things did happen. The noise was deafening. The engineer stood and grinned. I grinned too, but sheepishly; I was thinking seriously. An idea occurred to me that I could put my finger on the troublesome spot and cure it if we could shut down the engine. We tried to take some indicator diagrams and after six attempts got one which was nothing much more than a nest of lines.



FIGS. 1 TO 3. OIL-ENGINE PARTS, SHOWING BREAK
Fig. 1—Cracks in valve seat. Fig. 2—Section of valve. Fig. 3—Showing the repair

The engine made so much noise that I was afraid it would destroy itself, and I therefore had the load put on the small engine, which struggled, but got away with it.

We hurriedly dismantled the inlet and exhaust valves and removed the front cases which have an extension water-cooled part projecting into the compression space so as to better observe all interior parts. The exhaust valve was all right, but I saw some discoloration—a slight grayish deposit—on three nearly equidistant parts of the valve. Examining the valve seat in the head, the whole trouble was revealed. See Fig. 1.

The valve seat was integral with the cast cylinder head, and the seat projected beyond the main body casting, as may be plainly seen in Fig. 2. Local heating had caused unequal expansion, and the valve seat had cracked at three places. A knife blade could be inserted into each

crack. One of the cracks evidently communicated with the water space, for a slight oozing of water was visible. The engineer and the manager both viewed this with alarm, thinking a new head was necessary and meant at least five days' delay.

I lighted my pipe and sought a quiet place to think. That engine must be kept going. Soon I called for litharge and glycerin and some sixpenny nails. Holes were drilled, as shown in Fig. 3. In the meantime the engineer took down the water piping and opened all plugs provided on the head casting to facilitate cleaning the water spaces. A large quantity of rubbish, leaves, pieces of wood, iron borings, etc., was removed. The space was carefully inspected and everything replaced, after which water was forced through the head to note the amount that could pass. The engineer claimed that fully twice as much water was now passing through as before.

Cracks Filled with Litharge

I immediately filled up all cracks and holes with litharge and glycerin paste, and by filing the nails to a fairly tight drive fit, I forced them in and cut them flush with the surface with a piece of hacksaw and then peened the projecting part nicely. The manager came in to inquire as to what we had found and decided on, and I showed him the trouble and the cure I was administering and promised him that the engine would be as good as ever by midnight, that he need not order a new head and that the strain in the casting had now relieved itself, and he need not look for a recurrence of the trouble.

"Well," he says, "you ought to know; you're a mechanic and, I can see, an optimist." He promised us a good meal at 10 p.m. and went away. We got the meal and soon after had the valve seat scraped true, the exhaust and inlet valves ground to a true seat and the engine assembled. The crankpin-bearing shells were removed. In fact, we went over the engine in a thorough manner and put it in excellent condition by 1 a.m. The little engine seemed to be laboring considerably, so we decided to start the big one and see what would happen. It ran well.

We had not taken the load from the little engine too soon, for a serious pounding began in the crank case. We had lost a crankpin bearing.

Next morning we found that a pipe nipple which conveyed oil from the forced-feed pump to the crankpin and piston-pin bearings had broken off at the thread and that neither bearing could get oil. This was what caused the bearing to run hot. As the little engine needed a thorough overhauling, we dismantled the other crankpin bearing. No oilways were visible in it. We found the following troubles:

Middle bearing was low. This is indicated when the engine is operating by the flywheel running untrue or wabbling.

The piston had too much clearance, due to wear of the piston-pin brasses. This is indicated by low compression and inability to carry loads economically and by laboring hard even when the engine has not a full load.

Crankpins were more oval than round. This reveals itself by making it impossible to key up close and operate without noise or heating of the pins.

Main bearings were at too high a temperature. The engine will hunt, and the load it will carry becomes limited.

Ignition, when checked, seemed to be late. Ignition could be retarded 18 deg. late and advanced only to 10 deg. early. This is indicated by the engine not being able to carry normal load properly; by excessive heating of the cylinder heads, etc., unless a large quantity of water is passed through the jackets.

Poor oil had been used in the crank case. There was found about two inches of carbon "mud" in the bottom of the oil supply. This is shown by the fact that poor oil splashing against the piston head will burn and form carbon, while a good oil will not burn in this manner. The crank case was coated inside with about one-quarter inch of this mud.

This engine had always been hard to start with air. This is caused by the air-starting cams being out of timing with the motion of the piston in the starting cylinder, for if the air valve opens and the exhaust valve opens at 44 deg. from the outer center, it is evident that much of the power in the compressed air is lost. If the air cam opens late, it is evident that much of the potential (expansive) force of the air is lost.

The operators said that the engine governor never had been reliable except during the first three or four months after the engine was installed; in other words, the engine tended to race at light loads. It would not change from light to full loads suddenly without serious changes in speed and would not recover normal speed and voltage until after several minutes. In other words, the governor is extremely sluggish. Carbon around the governor valve (which was spool-shaped) caused such variable governor travel as to seriously interfere with the proper mixtures. For example, the gas and air openings are usually proportioned 50-50 on producer-gas engines. Therefore the carbon on the spool-shaped gas valve did not allow enough gas to enter to form a good mixture.

Uniflow Engine Drives Steam Car

One would hardly expect to find a condensing steam plant with a uniflow engine as a part of an automobile equipment, but that is what has been put into the Doble steam car, made by the General Engineering Co., Detroit, Mich., and being exhibited at the automobile shows.

The steam-power plant consists of a water-tube type of boiler made of sections that consist of two horizontal headers and connected by 16 vertical tubes. The bank of 28 sections is placed in an insulated casing. Eight of the sections are used as an economizer and are partly separated from the boiler sections by a baffle wall. Heat from the combustion chamber passes between the boiler sections in an upward direction and down past the economizer section.

Feed water enters the economizer and, when it is full, flows to the lower headers of the boiler sections. A proper water level is maintained by means of a bypass valve so arranged that when the regulator tube is filled with steam, the bypass valve is closed by the expansion of the tube, thus forcing the water from the pump to enter the boiler past the check valve. When the tube becomes filled with water, it contracts, thereby opening the bypass valve, and the water then goes to the supply tank. The normal steam pressure is 600 lb. The boiler is tested for 5000 lb. pressure, and a safety valve is set to pop at 1000 lb.

A two-cylinder uniflow type of engine drives the car. A slide valve regulates the admission of steam to each engine cylinder, and the exhaust passes out through ports that are uncovered by the pistons. No superheat is used, and the lubrication of the cylinders is thus simplified. Instead of feeding the oil to the cylinders, it is fed to the feed water and is emulsified with the water in the boiler. As the steam passes from the boiler, a certain amount of oil is carried along with it to the engine, thus lubricating the cylinders and valves.

Exhaust steam from the engine is carried to a radiator of large size. All the water of condensation enters the water tank near the bottom, so that should any steam find its way to the tank, it must pass up through the water and so be condensed. A vent is provided at the top of the water tank to guard against an accumulation of steam.

A simplified form of Joy valve gear is used that permits of reversing the direction of rotation of the engine. The engine cylinders are 5x4 in., and the cutoff ranges from 1/8 to 5/8 stroke.

Kerosene is used both for starting and for running. The boiler burner is ignited by a spark plug, and the fuel is forced to a float chamber by an air pressure of 3 lb. From the float chamber the oil is fed to a spray nozzle that projects into a venturi tube leading to the combustion chamber. Air is delivered to the spray nozzle by a motor-driven fan, where it atomizes the oil. As soon as the burner is ignited, the spark ceases automatically.

The car will run approximately 1100 mi. with one filling of the water tank (25 gal.), and is said to run 15 mi. on one gallon of fuel. One gallon of lubricating oil is sufficient to run the car 8000 mi.

Nugent Individual Oiling System

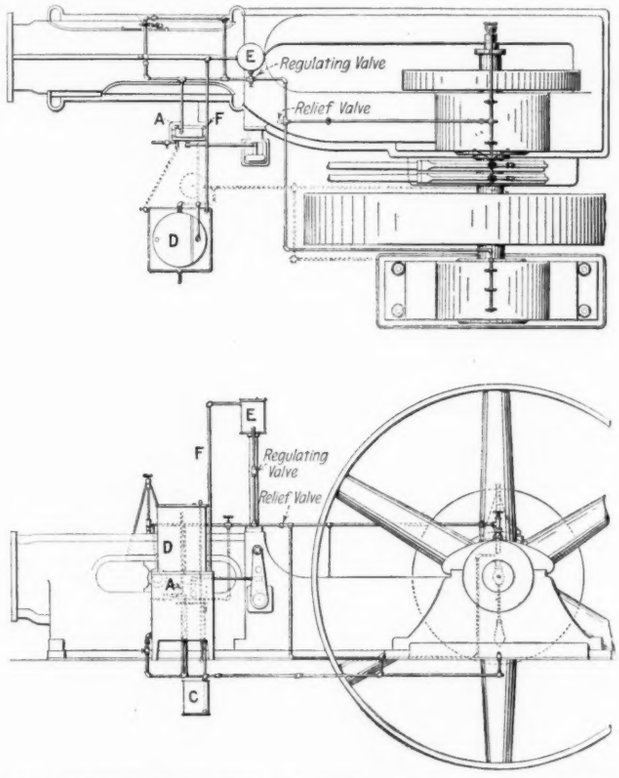
Individual oiling systems are commonly employed in power plants, and when there is no basement or the headroom is low, it is usual to place the filter on the engine-room floor, the oil being fed to the bearings by gravity from an expansion storage tank mounted on a pedestal supported by the engine frame. The oil from the bearings is collected and drained to a small tank placed low enough to receive it by gravity. A pump elevates the dirty oil to the filter and the clean oil from the filter reservoir to the expansion tank. Such a system is shown in the illustration, and it may be adapted to any type of engine. This system has been perfected by William W. Nugent & Co., of Chicago.

The features are a double-ended pump with adjustable stroke, a regulating valve provided for the purpose of maintaining a pressure on the system, if so desired, and a relief valve to prevent overpressure. The balance of the equipment is of standard Nugent design.

The pump consists of a main casting containing a plunger with a rack on the lower side, which meshes with a gear segment attached to a shaft running through the pump. On the outer end of this shaft is a lever having connection to some moving part of the engine. The lever has eight holes, so that the movement of the engine part may be suited to that of the plunger or the amount of oil pumped may be regulated by adjusting the stroke of the plunger. The lever is also adjustable on the shaft and may be set at any angle to vary the clearance at either end of the pump cylinder. This arrangement gives flexibility in the feeding of oil.

Dirty oil in the receiving tank is drawn up to the pump, while the clean oil will flow to it under head. It is thus possible to arrange the movement of the pump plunger, so that it will travel inwardly from its extreme position at one end of the stroke just enough to handle the dirty oil in the system without sucking air through the receiving well. This arrangement means that there will be large clearance at the clean-oil end of the plunger, but as the oil comes to this end by gravity, the pump's action will not be affected. The pump casting is provided with hollow chambers in the top to act as air cushions for the discharge of both ends, and it is equipped with steel ball valves which are accessible and may be removed through threaded caps at either end.

Referring to the illustration, the pump is located at *A* and through a rod is attached to the rocker arm of the engine. It elevates dirty oil from the drain tank *C* to the filter *D* and forces clean oil from the filter into the piping



ARRANGEMENT OF THE OIL PUMP, PIPING AND FILTER

serving the engine. The regulating valve is set to allow a certain pressure on the system, any excess oil escaping to the expansion tank *E* and eventually overflowing through the pipe *F* to the filter reservoir. With the regulating valve wide open the operation follows that of a simple gravity system. As a precaution to guard against excess pressure by the improper setting of the regulating valve, a relief valve has been provided. This is usually set to open at 10 lb. pressure and discharges to atmosphere, so that there will be immediate evidence of improper adjustment or some defect in the system.

Boiler Stresses—When to the customary working stress in boilers are added the stresses produced by unequal expansion, the factor of safety is reduced from, say, 5 to less than 2 and ruptures are only prevented by the great ductility of the steel of which boilers are now made. In former days, when iron was used, circumferential cracks and seam rips were frequent if steam was raised too rapidly.—C. E. Stromeyer.

Steam-Engine Troubles—Connecting-Rods

By H. Hamkens

SYNOPSIS—The advantages and disadvantages of many designs of hook rods are considered. Connecting-rod ends, their brasses and wedges are illustrated and discussed.

There are many different designs of hook rods—in fact, every Corliss-engine builder seems to have one of his own. Very few are entirely satisfactory; none is perfect. It is discouraging to note that after more than fifty years of Corliss-engine designing and building in this country, human ingenuity has been unable to overcome all the difficulties which the problem of producing

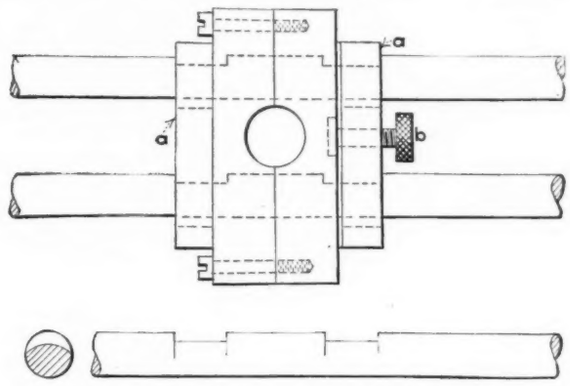
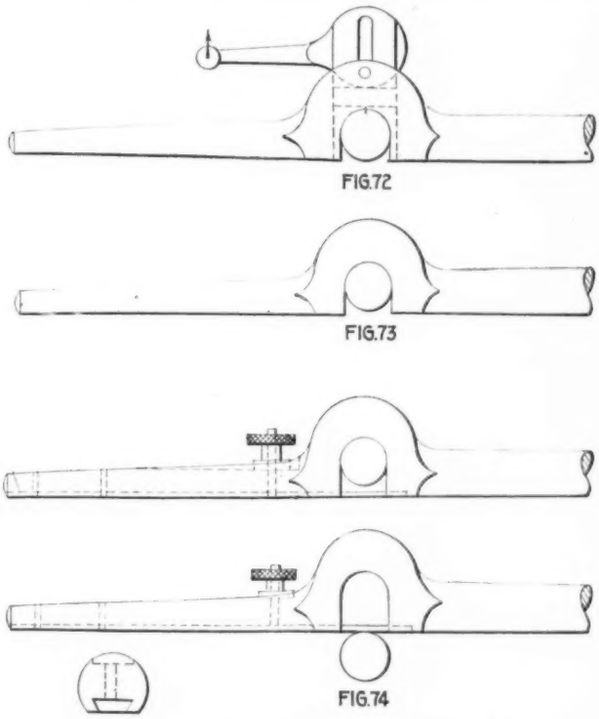


FIG. 71. AN INCONVENIENT HOOK ROD

a good hook rod presents. The most troublesome hook rod and its disengaging device are shown in Fig. 71. Instead of being in one rod, as most of the others, this one has two rods running parallel, both notched in two places, as shown in the detail. Two bars *aa* drop into the notches and are forced against the shoulders of the rod by tightening the setscrew *b*, which has a knurled head. To disengage the rod from the hook block, screw *b* is loosened and the bars *aa* are lifted out of the notches. In throwing the rods into gear again, the bars must be moved close up to the block and secured in the notches—the most awkward thing imaginable and dangerous to the fingers of the attendant. Anyone who has to handle this kind of device every day and does not get his fingers nipped once in a while is lucky.

Figs 72 and 73 represent two antiquated designs of hook rods. The difference between the two is, that the one shown in Fig. 73 has to be lifted out by hand and must be held by the operator or by slipping a ring on a chain over the end, while the one shown in Fig. 72 is lifted by moving the lever over in the direction of the arrow, thus throwing a small gib in position, which will make the rod slide over the hook pin. No provision is made to hold these rods on the pin except by their own weight; they are liable to be thrown out of gear and give trouble, if the valve gear begins to work a little harder than usual or if the load increases suddenly. To remedy this a dovetailed slide is arranged on the under side of the rod shown in Fig. 74. The slide answers the double purpose of keeping the rod in place and letting it slide forward and backward over the pin when lifted out. It has to be lifted by hand.

To avoid the lifting of the hook rod has been the aim of many designers, most prominent among them the late Edwin Reynolds, of Milwaukee, to whom the device shown in Fig. 75 is credited. The object of the different designs is to let the rod slide through a block engaging and disengaging it at will in a certain place. In Mr. Reynolds' device a casting *A* is bolted to the wristplate and bored out to receive the block *B*, in which is located the pin *C*, having a handle *D* fastened to the outer end. The hook rod *E* runs through holes in *A* and *B*, holding them together. The pin *C* has a shoulder on which a spiral spring rests, forcing the taper end of *C* into a corresponding hole in rod *E*. To disengage the rod and block, *D* is turned around until a small pin strikes a stop, when *C* can be pulled back, the neck of *B* having a slot, through which the small pin passes. When the pin gets on the outside, *D* is turned about one-quarter of a turn, which locks *C*. To engage the rod again, *D* is turned back so that the pin can slip through the slot, when *C* will be made to find the taper hole in *E* by moving the wristplate forward and backward. To lock the mechanism the handle *D* is turned ahead till



FIGS. 72 TO 74. TYPES OF HOOK RODS

Figs. 72 and 73 may unlock themselves and give trouble. Fig. 74 has dovetailed slide to prevent unlocking

C is tight in the rod *E*. It was soon demonstrated that this device would do for light work only; on heavy work the force applied to the taper pin was not sufficient to hold the hook rod tight. To remedy the trouble the arrangement shown in Fig. 76 was adopted, in which pin *C* acts only as a finder, while the screw *F* secures the rod. Two operations are required to throw the rod in and out of gear, and it is rather confusing to the engineer to remember which of the two handles he has to turn first.

Fig. 77 shows a modification of the last-described disengaging device. The number of parts has been reduced; it has the finder and the screw to tighten the rod, but there is only one handle and one-half turn in one direction or the other will release or fasten the hook rod. This device fills all requirements except that of taking up the wear in the wristplate. However, it a hammer is often used to force the lever over and tighten the rod. Neither of the devices is immune from trouble; there are cases on record where the rod slipped in the block and part of the valve gear was broken.

Some hook rods are made on the telescopic principle; that is, the rods are made to slide in a sleeve provided with a disengaging device similar to those shown in Figs.

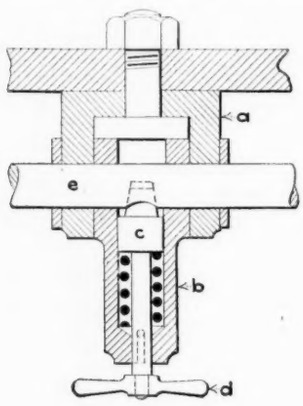


FIG. 75

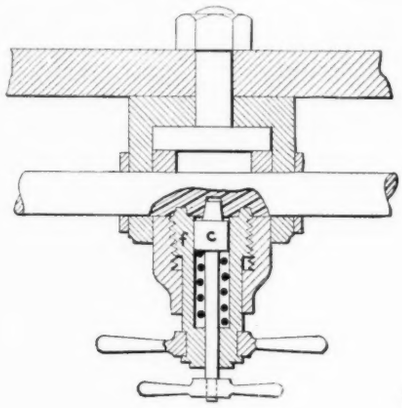


FIG. 76

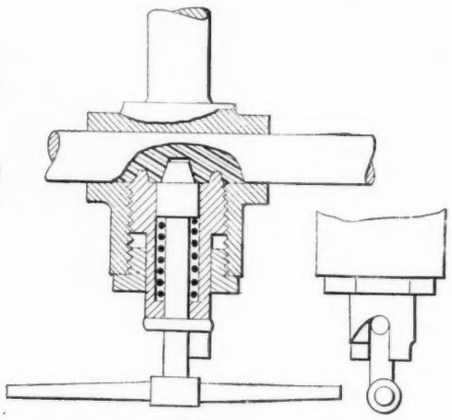


FIG. 77

FIGS. 75 TO 77. HOOK-ROD DISENGAGING DEVICES

Fig. 75—Reynolds' design. Fig. 76—Locking device for heavy engines. Fig. 77—Has one handle but embodies most of the advantages of Fig. 76

will last for years with proper attention and adequate lubrication.

The two devices shown in Figs. 78 and 79 use a finder to locate the rod in the required position, but to secure it they draw the hook block, which is split half way through for that purpose, together by means of a handle and screw and clamp the rod. In Fig. 78 the performance is ingeniously carried out by simply turning the lever one way or the other, which at the same time works the finder and loosens or clamps the rod. In Fig. 76 and 77, or they are made on the same order as shown in Fig. 80, in which a toothed clutch is used. In this device care must be taken to have the rod and sleeve engage in the right place. If the clutch catches on the wrong tooth, the result is very likely to be a twisted valve stem or broken bonnet.

There is another device, shown in Fig. 82, that deserves mention. It is of similar style to the rod, Fig. 72, but much improved inasmuch as it will not only lift the rod out in turning the handle to the right and let

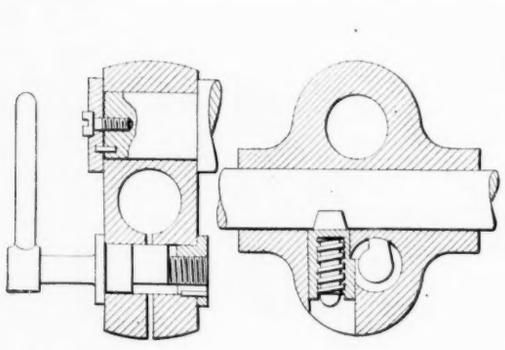


FIG. 78

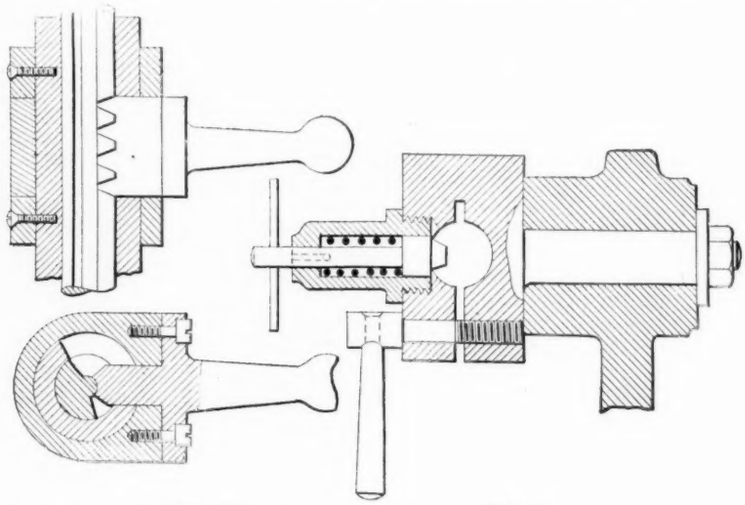


FIG. 80 FIG. 79

FIGS. 78 TO 80. OTHER TYPES OF HOOK-ROD DISENGAGING DEVICES

Fig. 78—The rod is clamped or loosened by merely turning the lever. Fig. 79—The finder and clamping devices are separately operated. Fig. 80—The toothed clutch

79 finder and clamping device are separate, each working independently of the other. Therefore the engineer always has to remember which to manipulate first. Devices of this kind that depend on clamping the rod are likely to give trouble in the larger sizes, where much force must be applied to the lever to get an efficient grip on the rod. To insure a good hold, a piece of pipe or even it slide over the hook pin, but it will also keep the rod from jumping off the pin when thrown in gear. There are many other devices, from taper pins to hardened-steel latches, but little faith can be placed in them.

Two of the older designs of connecting-rod ends are shown in Figs. 81 and 83. Rod ends like Fig. 81, with gibs and key, were used first. They answered the pur-

pose for slow speeds, say 60 or 65 r.p.m.; with increased speeds the gibs gave trouble and were abandoned for through bolts like Fig. 83. Many rods of this kind are still in use. The trouble with them is that the keys will hammer into the boxes and have to be taken up frequently. These strap-end rods were very convenient when forgings were made of wrought iron welded together from "selected scrap"; it was easier in those days to make the rods in several pieces than in one. With the advent of openhearth steel the built-up rod became obsolete and the solid-end rod, forged in one piece from a billet, made its appearance. The strap rod, shown in Fig. 84, is disappearing; no modern engine builder would make one except for a special occasion. On rods of this kind both keys are on the inside. As the boxes wear and the keys are taken up, the distance between centers gradually increases and the consequence is that the clearance in the cylinder begins to vary. On old engines this has to be watched closely, otherwise there may be trouble with the piston striking the back head. To keep the distance between centers about the same, shims are put between the boxes and the straps, an expedient which can not be recommended.

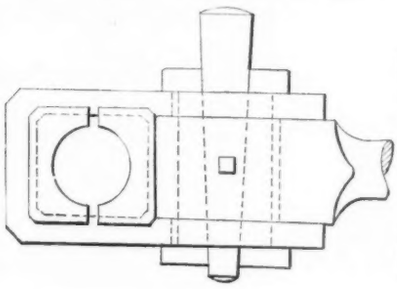


FIG. 81. CONNECTING-ROD END WITH GIB AND KEY ONLY

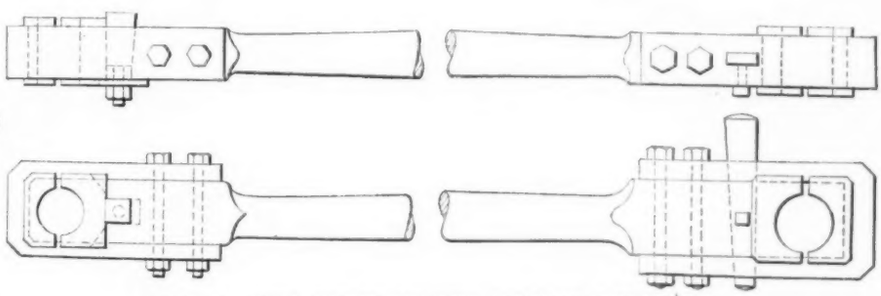


FIG. 84. TWO VIEWS OF THE COMMON STRAPPED CONNECTING-ROD

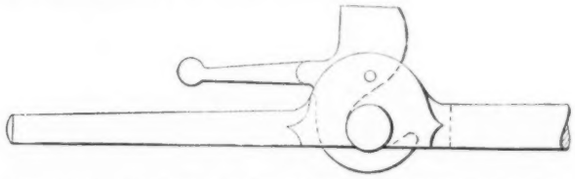


FIG. 82. A SIMPLE AND SAFE ENGAGING DEVICE

On engines where the crosshead pin cannot be removed, or which have a center crank, the connecting-rod must be made so that it can be taken apart, and under such conditions the rod ends shown in Figs. 85 and 86 can be used to advantage, the former for the crosshead end and the latter for the crank end. The adjustment is made by means of wedges held in place by tapbolts. The wedge at the crank end is placed on the outside and the one at the crosshead end on the inside, so that any adjustment for wear will leave the distance between the centers of boxes practically constant. The marine end shown in Fig. 87 is sometimes used on the crankpin, but with indifferent success; it is very hard to adjust, especially in the larger sizes. Here again we have to do with shims, which are placed between the cap and the rod, and as the boxes wear some of them are taken out and the nuts are drawn up tight again—certainly the crudest way of adjustment that can be conceived.

There is also the hatchet rod, shown in Fig. 88, a substitute for the marine rod. The upper side is solid, but the lower is cut out so that the rod can be lifted off the crankpin by removing the large bolt and the block that fills the gap. Fig. 89 represents a forked rod which is cut through at the extreme end. The opening is closed by means of a steel block which is recessed into the two sides of the rod. A large bolt holds the ends and block together. The adjustment of these two rods is effected by wedges located near the outside of the rods. Neither the hatchet nor the forked rod finds much favor. They are cumbersome, require the highest class of workmanship and, if the blocks and bolts are not a very good fit, will give a good deal of trouble.

In an uptodate Corliss engine the connecting-rod designs just described should not be accepted; the solid-end rod is the only one which can be recommended. There are, of course, many different designs of the latter, for each of which a number of claims of superiority are advanced. Fig. 90 shows a solid-end rod provided with boxes which, it is claimed, cannot pinch the pins. They are not split in the center in the customary way, but are slotted out on one side, into which the adjustable part of the box fits. On the crosshead end the adjusting wedge is located parallel to the crosshead pin; the object of this is to make the wedge accessible outside of the crosshead, where it can be given close attention. The

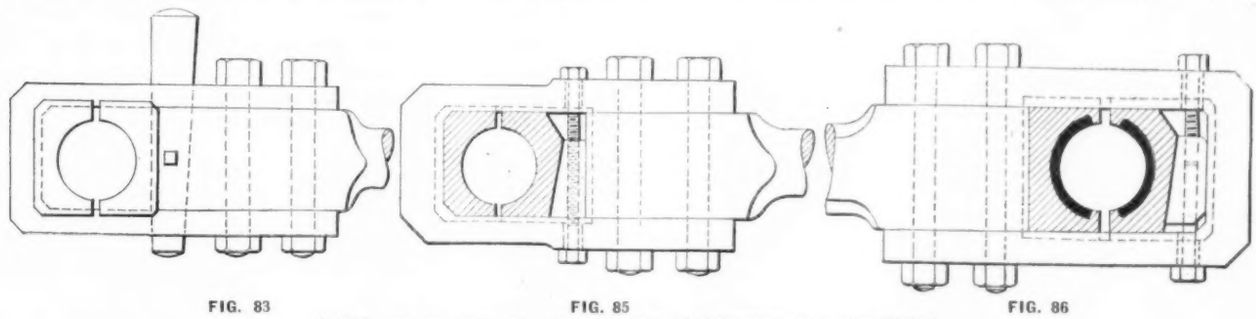


FIG. 83 FIG. 85 FIG. 86

FIGS. 83, 85 AND 86. TYPES OF CONNECTING-ROD ENDS

Fig. 83—Similar to Fig. 81, but with through bolts. Figs. 85 and 86—Other designs of connecting-rod ends

advantages of the rod seem to be that the boxes are cylindrical and can therefore be fitted easily and that most of the operations on the rod are performed by turning, boring and milling. The disadvantages lie in the long slot at the crosshead end, which is apt to spring, and in small surface of the adjusting wedge at the crank end.

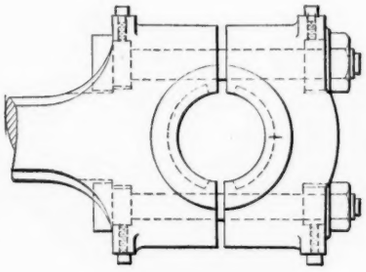


FIG. 87. MARINE END CONNECTING-ROD

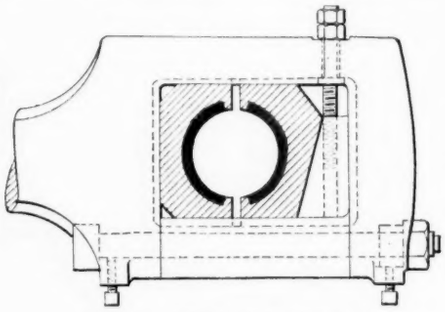


FIG. 88. THE HATCHET ROD END

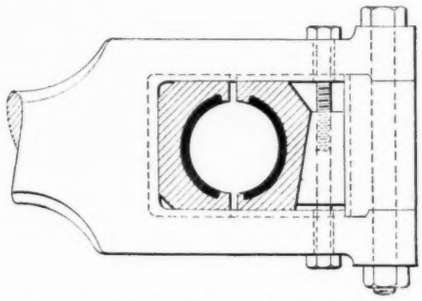
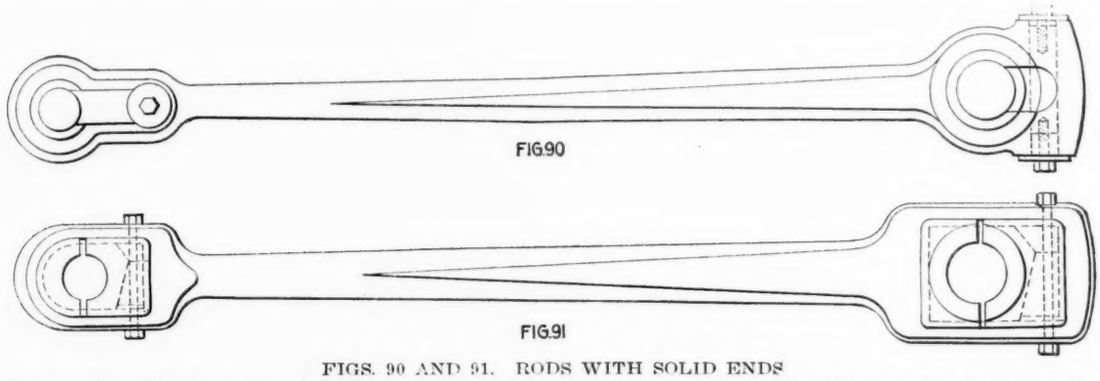


FIG. 89. THE END OF THE ROD IS CLOSED WITH A FILL PIECE

The rod shown in Fig. 91 represents what might be called the ideal one for a Corliss engine; it fills all the requirements and, on account of its simplicity, strength and reliability, has been almost universally adopted as the standard. There are no frills about this kind of rod; everything seems to have been logically developed. The rod is forged in one piece, turned in the lathe, the sides planed, and the end slotted out and squared to receive the boxes and wedges. The surfaces that come in contact between the boxes and wedges are very large and the pressure per square inch on these surfaces is consequently much reduced. The best material for the wedges is forged steel. Cast iron is not suitable for this purpose; it is likely to break through the threaded hole and give trouble. The tapbolts must have a good fit in the wedge, but they should be loose in the rods, with at least $\frac{1}{16}$-in. play or, in the larger sizes, $\frac{1}{8}$-in. If they are made to fit tightly, there will be trouble, as they will break in a short time. Norway iron or its equivalent is the best material for the tapbolts; mild steel is likely to crystallize and break. A small fillet should be left between the shank and the head of the bolts, and sharp corners must be avoided.

It has been said that the space above the wedge for adjustment is objectionable and that the box and wedge should bear over their entire surface. In Fig. 92 an attempt is made to overcome this difficulty. The wedge is inserted from the front, it bears over the full surface of the outer box and is held in place and adjusted by means of a screw-bolt. A setscrew from underneath helps to secure the wedge; this is placed in a horizontal position instead of vertical, as in Fig. 91. This small setscrew, which is used as a check in addition to the large bolt, shows that the confidence of the makers of this kind of rod is not quite supreme as to the staying qualities of the wedge. The projecting bolt and nuts, in front, where the engineer has to feel the rod, are objectionable.



FIGS. 90 AND 91. RODS WITH SOLID ENDS

Fig. 90—Has cylinder boxes that are adjustable though not split. Fig. 91—The ideal rod for Corliss engines

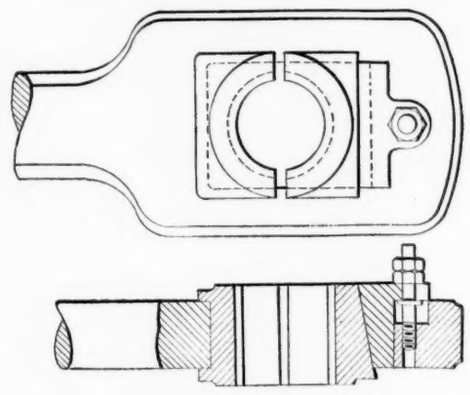


FIG. 92. WEDGE BEARING FULL ON BOX

[*The next article of the series tells of dashpots and the troubles they are heir to.*]

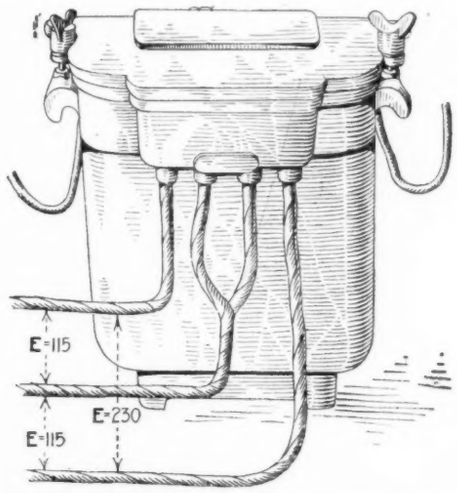
Experiments in Waterproofing Concrete—An investigation of the integral method of waterproofing concrete has been undertaken by the United States Bureau of Standards in coöperation with manufacturers of compounds, and with societies, engineers and others interested in this problem. A questionaire has been addressed to more than 800 architects, engineers, contractors, etc., and the tabulation of the replies received has been started by the bureau. An important feature of the investigation is the project for experimental concrete tanks along the river front at Washington. The District Government has set aside a small piece of ground and plans have been completed for constructing the tanks.—"Commerce Reports."

Tapped the Wrong Wire

By E. C. Parham

Where single-phase service is carried to consumers who may use both lighting service and current for operating small single-phase motors, it is sometimes advisable to install service transformers that have two secondary coils connected in series, so that 230-volt motors can be operated from the two outside secondary mains and 115-volt lamps from the middle main and either outside main, as shown in the figure. Where the three wires are brought into a house, it is important that the middle or neutral wire be everywhere kept in the middle so that it can always be identified with certainty; otherwise a 115-volt device may be injured by placing it across 230 volts or a 230-volt device may give unsatisfactory service on account of being connected to the 115-volt mains.

Electromagnetically operated contactors that are used on automatic motor-starting outfits are designed to safely stand from 10 to 15 per cent. over-voltage; also they will



TRANSFORMER SECONDARIES CONNECTED FOR THREE-WIRE, 115 TO 230 VOLTS

operate satisfactorily on a voltage that is considerably below their rating. However, it would be unreasonable to expect a standard contactor to satisfactorily operate on a voltage that is 50 per cent. low. Nor would it be advisable, as a rule, to have a contactor satisfactorily operate on a greatly reduced voltage, because the motor might be subjected to abusive conditions of operation.

A single-phase motor that had been installed to drive a pump for supplying water from a well did not have strength enough to start the pump even when no water was being lifted. The lighting company that sold the outfit sent an inspector to investigate. At first glance everything appeared to be all right as far as the connections were concerned. On trying to start the motor, however, a starting relay which was dependent for action on the pressure-governor contact gave a healthy click, but the starting contactor failed to close. In exploring the contactor-operating circuit with a 230-volt test lamp, in order to locate any open circuit that might exist, it was found that the voltage actually applied to the contactor circuit was way below normal; further testing with the lamp disclosed that the voltage of the mains from which all circuits derived current was about half what it should have been. The tracing of the wires from the motor to where they tapped on to the house busses revealed the source of trouble: Owing to some confusion of taps, 115-volt instead of 230-volt service had been carried to the motor. The changing of one tap from the middle to the outside main eliminated all trouble.

Defender Draft Gages

A complete set of single, duplex and differential draft gages has recently been designed by the Defender Automatic Regulator Co., of St. Louis. A standard back to

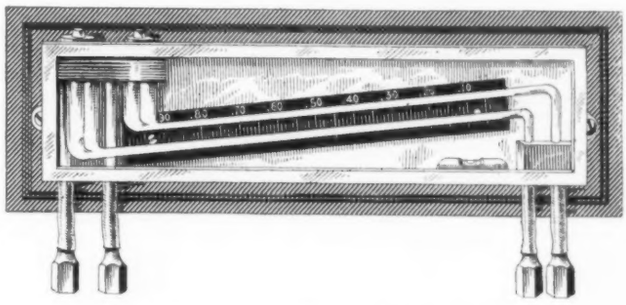


FIG. 1. DUPLEX DIFFERENTIAL DRAFT GAGE

which any one of the three types of gage may be secured has been provided, end rather than top connections for the differential gage making this possible. The back is provided with a hood to protect the gages from dust or water, and if the gage is to be installed in a dark place provision in the hood may be made for an incandescent light. (See page 910, June 27, 1916, issue.)

Fig. 1 shows the differential duplex draft gage with bottom connections. The top gage may be used to measure the drop in draft through the fuel bed and the bottom

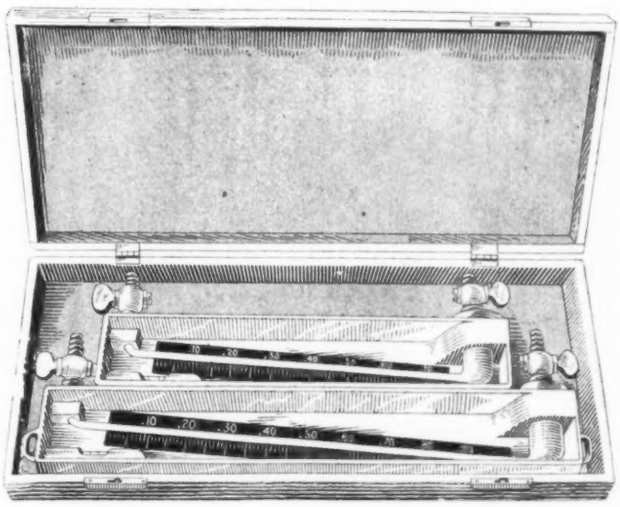


FIG. 2. PORTABLE SET OF DIFFERENTIAL GAGES

gage the drop through the boiler or between any two points desired in the boiler, flue or economizer. Another design has end connections. A 2-in. single-tube differential gage has a U-tube attached for reading the draft in the ashpit. The latter gage is employed when the plant is equipped with underfeed stokers or for any other reason may have forced draft. Fig. 2 is a portable differential outfit with pet-cocks mounted on top connections so that the oil may be carried in the gages.

Steam Engineer's License Examination—III

By H. F. Gauss

SYNOPSIS—A discussion of reciprocating and centrifugal boiler-feed pumps, giving distinctive types, operating difficulties, valve setting, the need of air chambers and piping layout.

There are several direct-acting boiler-feed pumps on the market, the distinguishing characteristic being the number of cylinders the pump is provided with; that is, whether the pump is single or duplex. The main steam valve of a single-cylinder pump is operated by means of an auxiliary valve, which in turn is operated by the motion of the piston. Examples of single-cylinder direct-acting pumps are the Knowles, Cameron, Marsh and Gordon steam pumps.

Each of these pumps illustrates a distinct method of operating the auxiliary steam valve, and a description of

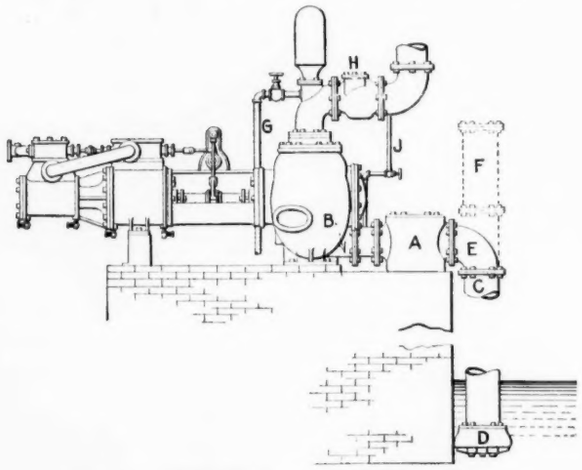


FIG. 1. CONNECTIONS OF WORTHINGTON COMPOUND PUMP

the construction of each may be found in the respective manufacturer's catalog. An interesting point to study is the methods of governing in each case; that is, the means employed to prevent the piston and plunger from striking the cylinder heads a hard blow, in case the delivery pipe should suddenly burst or the pressure against which the pump is working should suddenly be reduced. A further description of these pumps will not be entered into here, as those interested can easily secure descriptive catalogs which give more complete information than space in the present article will permit.

Duplex pumps are so designed that the steam valves of each side are thrown by the piston rod of the opposite side. In discussing the different qualities of the duplex pump, the following points may be emphasized. As just stated, the steam valves in each cylinder are operated by the rod of the opposite cylinder. The motion is transmitted from the rods to the valves through levers pivoted on the frame. It is to be noticed that one of these levers changes the motion of the valve to the opposite direction from that of the rod driving it, while the other lever transmits the motion in the same direction. This is an important detail, as it causes the pistons to move in opposite directions, and by properly adjusting the lost motion in the valves each piston can be made to take up the work laid down by the other shortly before the other reaches the end of its stroke, thus maintaining a uniform pressure in the delivery pipe. The lost motion can be regulated by means of locknuts on the valve stems, generally inside the steam chests. Another function of this lost motion is to cause a slight pause, or dwell, at the end of the stroke, which allows the valves to seat quietly in the water end of the pump, thus preventing shock and water-hammer.

Each steam cylinder is provided with separate steam and exhaust ports, so arranged that as the piston approaches the end of its stroke, it passes over and closes the exhaust port, preventing the further escape of steam, while that trapped in the cylinder is compressed, forming a cushion and preventing the piston from striking the head. The use of the double ports necessitates a large valve, thus insuring ample valve area and preventing rapid wear, while at the same time a short throw is maintained.

An imperfection frequently found in duplex pumps is the fact that they short-stroke. This is apt to cause a shoulder to wear at the end of the stroke, and when the pump is corrected and made to complete its stroke, it runs onto the shoulder and sticks. This short stroke is sometimes caused by the cushion being too great, owing to a decrease in speed. When due to this cause, it may be corrected by the use of what are called dash relief valves.

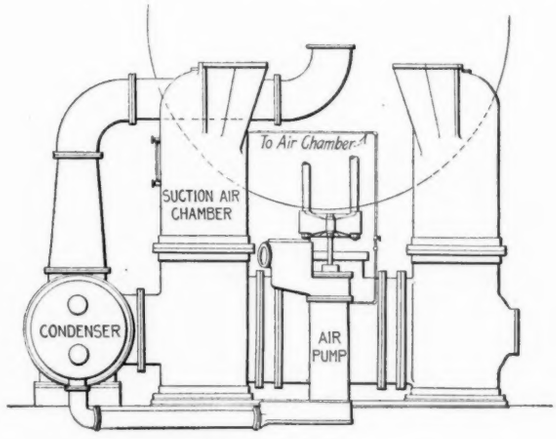


FIG. 2. CONDENSER AIR PUMP

A dash relief valve is simply a small hand-operated valve between the steam and exhaust passages. By opening this valve slightly, a connection to the exhaust is maintained even after the piston has closed the main exhaust port, and the cushion pressure cannot build up so high.

An example will show clearly the application of the valve in practice. Take a duplex pump supplying two 350-hp. boilers. It must deliver approximately 21,000 lb. of water per hour. Now let one boiler be shut down, and the pump is called on for only 10,500 lb. of water per hour. When supplying the two boilers, the pump must run at twice the speed as when delivering water for one; and the inertia of the moving parts requires a high cushion pressure to stop them. Under this condition the dash relief valves should be closed. At the lower speed, however, the inertia of the moving parts is less, and with

the relief valves closed, the piston would be stopped at some point short of that reached at the higher speed. By properly adjusting the relief valves, the piston can be made to take full stroke at any speed. This is not possible without the relief valve. However, a bypass is often provided from the delivery pipe back into the suction pipe. By the regulation of a valve in this bypass the speed of the pump may be maintained constant at all rates of delivery, and the necessity of a relief valve is eliminated.

Should the pump have to handle hot water—that is, water above 120 deg. F.—it should be so arranged that the supply flows to the pump by gravity and does not have to be lifted by suction. The reason for this is that at the reduced pressure in the suction pipe the boiling point is also reduced, which means that on the suction stroke the piston is followed up by steam instead of water. It sometimes happens that in the handling of hot water the pump refuses to take water into the cylinder even when supplied under a head. This occurs when the suction head is not sufficient to hold the suction valves open. After some water has entered the cylinder, it flashes into steam, destroying the vacuum and causing the suction valves to close so that no more water may enter the cylinder. On the return stroke the piston will probably slam. The remedy for this condition is to decrease the stiffness of the valve springs, or to increase the suction head by raising the water supply or lowering the pump. When these remedies cannot be resorted to, the hotwell temperature must be reduced. Of course the temporary remedy for a steambound

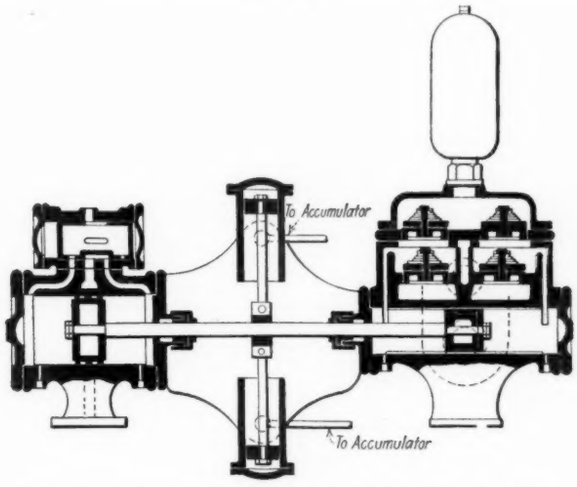


FIG. 3. HIGH-DUTY ATTACHMENT FOR SIMPLE DIRECT-ACTING PUMP

pump is to cool the cylinder by throwing cold water on it and into the hotwell.

Complete directions for installing and operating pumps can be obtained from the manufacturer of the pump in question. However, certain fundamental points are to be remembered in arranging the connections of steam pumps in general. It is advisable to provide a reliable foot valve at the bottom of the suction pipe, unless the pump operates under a suction head. This often prevents the pump losing its prime when stopped and saves time and trouble. It is also good practice to place a check valve in the delivery line close to the pump, as frequently, with the entire head resting on the delivery valves, difficulty in starting up is experienced due to air trapped under the delivery deck. This air, of course, is compressed on the delivery stroke, but not enough to open the valves; and on the suction stroke it expands, preventing more water from entering the cylinder. With a check valve in the delivery pipe, the pressure on top of the delivery valves may be removed by opening a relief valve located in the discharge chamber, or at the bottom of the air chamber. After the air has all been discharged and water flows freely from the relief valve, it may be closed and the pump will deliver.

A connection from the far side of the check valve in the delivery pipe, back into the suction pipe, provided with a valve, will serve to prime the pump should it lose its suction, and will also form a bypass back into the suction should too great a quantity of water be delivered.

With dirty water or water containing foreign matter in suspension which might score the cylinder and valves, a strainer should be provided in the suction line close up to the pump and in an easily accessible place. For high lifts (10 ft. or more), a suction air chamber is desirable if not necessary. A neat air chamber can be secured by ex-

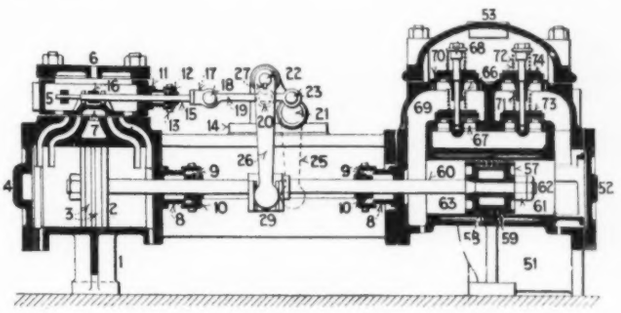


FIG. 4. PRESCOTT DUPLEX PISTON-PATTERN BOILER-FEED PUMP WITH NOMENCLATURE OF PARTS

1, steam cylinder; 2, steam piston; 3, steam-piston ring; 4, steam-cylinder head; 5, steam chest; 6, steam-chest cover; 7, slide valve; 8, piston-rod stuffing-box; 9, piston-rod stuffing-box gland; 10, piston-rod stuffing-box follower; 11, valve-rod stuffing-box; 12, valve-rod stuffing-box gland; 13, valve-rod stuffing-box follower; 14, cross-stand; 15, valve rod; 16, valve-rod nut; 17, valve-rod head; 18, valve-rod head pin; 19, valve-rod link, long; 20, valve-rod link, short; 21, short crank and rockshaft; 22, long crank and rockshaft; 23 crankpin; 25, short lever; 26, long lever; 27, lever key; 29, crosshead; 51, pump body; 52, water-cylinder head; 53, force chamber; 56, water-piston; 57, water piston follower, 58, water-piston packing; 59, water-piston spring ring; 60, piston rod; 61, piston-rod nut; 62, piston-rod locknut; 63, removable liner; 66, discharge-valve seat; 67, suction-valve seat; 68, valve spindle; 69, suction valve; 70, discharge valve; 71, suction-valve spring; 72, discharge-valve spring; 73, suction-valve plate; 74, discharge-valve plate.

tending the vertical suction pipe a few feet above the pump inlet and capping it.

Fig. 1 is a drawing showing the piping recommended by the Worthington Pump and Machinery Corporation. It may be found in one of their bulletins and is substantially as outlined. In the drawing *D* is the foot valve, *C* the suction pipe, *F* the vacuum chamber or suction air chamber, *G* the test valve and air-relief valve, *H* the check valve in the delivery pipe, *J* the priming pipe and *A* the strainer.

With large pumping engines it is often possible to connect the suction air chamber with the air pump on the condenser, and maintain a vacuum of 15 in. or more in the chamber without disturbing the vacuum in the condenser at all. This can easily be accomplished when the air pump contains a deck of delivery valves, a deck of suction valves and a bucket plunger having valves opening toward the delivery side. The connection to the air pump is made just beneath the delivery deck, the air being exhausted from the suction chamber on the return stroke of the air pumps. Fig. 2 shows clearly the arrangement referred to and represents this connection applied to a 20,000,000-gal. pumping engine.

The ordinary simple direct-acting steam pump, single or duplex, does not use steam expansively, but takes it during full stroke. Under the most favorable conditions these pumps do not average a duty higher than 10 to 12 million foot-pounds per 1000 lb. of saturated steam at 100 lb. gage. The steam valve has no lap; that is, in mid-position it just covers the ports, and at reversals it is moved quickly, remaining at rest throughout a large part of the stroke. Compound and triple-expansion direct-acting pumps, however, are designed to cut off at a fraction of the stroke in the high-pressure cylinder, which exhausts directly into the intermediate cylinder in the case of triple-expansion pumps and into the low-pressure cylinder in the case of compound pumps. The intermediate and low-pressure cylinders generally take steam throughout the entire stroke.

A device which has been used, called a high-duty attachment, makes it possible to cut off at a fraction of the

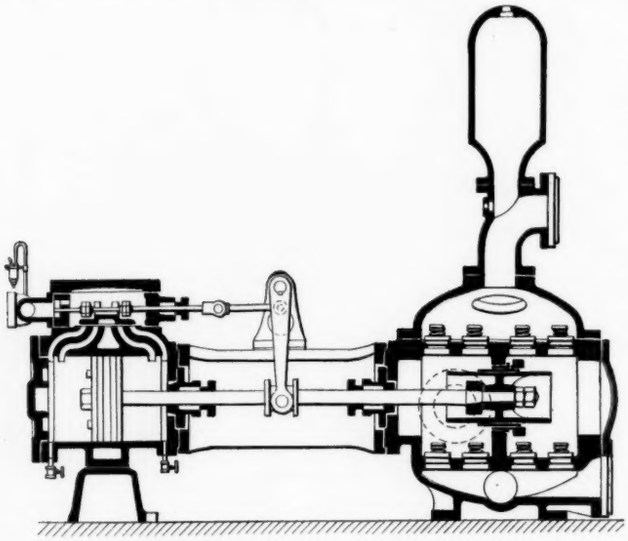


FIG. 5. SNOW STEAM PUMP WITH NUT ON EITHER SIDE OF VALVE

stroke in simple direct-acting pumps. This arrangement is not common and seems to be growing out of favor, owing to its complicated mechanism. It consists of two hydraulic cylinders supported vertically on trunnions, one above the main piston rod and one below it. The outer ends of the plunger rods in these cylinders are attached to the main piston rod by means of a ball-and-socket joint. As the pump travels back and forth, the hydraulic plungers are carried in and out of their cylinders. With the pump in mid-position, the hydraulic cylinders stand vertically one above the other. At the beginning of the stroke the plungers are drawn out and the hydraulic cylinders incline against the direction of the stroke, so that up to mid-position the plungers are forced in, driving the water or oil with which the attachment is charged, into an accumulator. After mid-position is passed, the hydraulic cylinders incline with the direction of the stroke, and the pressure within the accumulator forces the plungers out, which in turn push on the main piston rod and aid the pump. Up to half-stroke then, the steam pressure, in addition to driving the water end, forces the hydraulic plungers into their cylinders, storing energy in the accumulator. If steam is cut off at half-stroke, that already in the cylinder will work expansively and will be assisted by the energy stored in the accumulator, which drives the hydraulic plungers out, pushing on the main piston rod. These plungers become more efficient toward the end of the stroke as they push more nearly parallel to the piston rod. Fig. 3 illustrates diagrammatically this construction.

The question often comes up as to just how to set the valves on a duplex pump. The following method is given in a Worthington catalog. Fig. 4 represents a pump valve with a single nut for moving it. Fig. 5 shows a valve moved by double nuts. To set a valve of the type shown in Fig. 4, proceed as follows:

Place one piston in the middle of its stroke and disconnect the link from the head of the valve rod on the opposite side. Then set the valve in its central position, place the valve nut evenly between the jaws on the back of the valve, screw the valve rod in or out until the eye in the valve-rod head comes in line with the eye of the valve-rod link, and reconnect. Repeat the operation on the opposite side, and the valves will be properly set.

To set a valve of the type shown in Fig. 5, place one piston in the middle of its stroke and the opposite slide valve in the central position, adjust the locknuts so as to allow about $\frac{1}{16}$ in. lost motion on each side of the valve jaw, and the valve is set. Do not disconnect the valve motion, but repeat the operation for the opposite side. It is advisable to place both pistons in mid-position before touching either side. Too much lost motion will tend to lengthen the stroke, and may cause the piston to strike the heads, while too little lost motion will tend to shorten the stroke.

Reciprocating boiler-feed pumps require the careful attention of the man in charge to secure satisfactory operation. Care must be used in adjusting the feed valves, not to close the pump discharge entirely; or the bypass valve must be adjusted, in order to protect the water end of the pump, in case the discharge is throttled down. These and other operating difficulties may be entirely eliminated by the use of a centrifugal boiler-feed pump, either turbine or motor-driven.

The writer is acquainted with two turbine-driven centrifugal boiler-feed pumps. The pipe line from these pumps is about 250 ft. long, and they are located some 45 ft. below the boiler-room floor. Each is designed to deliver 50,000 lb. of water against a head of 190 lb. per sq.in. As yet no tests have been made on these pumps to determine their efficiency, but many similar installations are at present in successful and economical operation.

One of the greatest advantages of the centrifugal boiler-feed pump is that the discharge valve may be closed entirely without causing sufficient pressure rise to injure the pump or connections. The foregoing remarks, while pertaining directly to the centrifugal boiler-feed pump, may be applied to other types of centrifugal pumps as well. Sump pumps may often be centrifugal, as well as larger pumps up to capacities of 20 to 30 million gallons in 24 hours. The writer is familiar with a turbine-driven centrifugal pump of 25 million gallons' capacity in 24 hours, delivering against a head of 115 ft. and showing a duty of 145,000,000 ft.-lb. of work per 1000 lb. of steam at 160 lb. gage pressure and 100 deg. superheat. At higher heads the triple-expansion crank and flywheel pumping engine still holds the record for high economies. A 20-million gallon crank-and-flywheel pump at the Bissel's Point Station of the St. Louis Water Works recently showed a duty of 202,000,000 ft.-lb. of work per 1000 lb. of steam at 160 lb. pressure and 100 deg. superheat when delivering water against a 300-ft. head.

On page 52 (Jan. 9), second column, the value of n should be corrected to read $n = n_1 + 2n_2$, and on page 53, $h = 17.41$ and not 16.54 as given—the $+\frac{7}{8}$ was left out by the editor.

Editorials

What Is Gasoline?

In the days when the kerosene lamp was the universal luminant, the lighter products of the distillation of petroleum were a drug upon the market and laws were passed to keep the refiner from putting so much of them into the commercial kerosene as to make it overvolatile and liable to throw off inflammable gases at ordinary temperatures. With the general introduction first of gas, in even small communities, and later of the electric light everywhere, the demand for illuminating oil decreased. Concurrently with the development of the gasoline engine and its rapidly extending use in automobile practice, motor boats, etc., the demand for the lighter products of combustion has increased until it has become a problem to supply them. A few years ago the sale of motor fluid below seventy degrees Baumé as gasoline would have been regarded as a transaction warranting a remonstrance on the part of the purchaser and an explanation on the part of the vender. Today stock having a gravity of sixty degrees, Baumé is considered excellent, and all sorts of processes of cracking heavier products and squeezing gasoline out of natural gas are employed to keep up the supply. The temptation now is to make the much-demanded lighter products carry as much of the less salable heavier products as the purchaser will stand for. Whence the question—How much cheap kerosene can the purveyor mix with the more expensive lighter products and be allowed to sell the mixture as gasoline?

At the request of the United States Government a joint committee of the Bureaus of Standards and of Mines is considering this question with regard to specifications for Government purchases, and as specifications recommended by such a committee and adopted by the Government would be likely to form the basis for urgently demanded state and municipal legislation, the let-us-alone people were out in full force at the hearings at the Bureau of Standards week before last, to demonstrate that any attempt to make them tell what they were selling for gasoline would be unwarranted interference, hyperpaternalism and would result in a disastrous curtailment of the supply and a further enhancement of the selling price.

It is difficult to see how any honest refiner or dealer can object to the committee's suggestion that all motor fuels be labeled with two numbers, as "100—200," the first signifying the temperature at which twenty per cent. of the fluid in question would volatilize, and the second that at which ninety or ninety-five (or whatever percentage the committee may finally agree upon) would volatilize. This use of the label would in no wise restrict the output, for under it everything may be sold that may now be sold, only the purchaser is furnished with a yardstick with which to measure his purchase. Some engines will run on a heavier fluid than others. Any engine will run satisfactorily on a heavier fluid in warm than in cold weather. The owner or chauffeur can buy—if he can get it—that which he thinks is best adapted to his present use, and is not induced to buy a cheap mixture of gasoline and kerosene at a cent or two less per gallon. The man who prefers to buy the high-priced highly volatile product all the time, and avoid carburetor troubles, will be assured that he is getting what he is paying for, and he who is willing to experiment with the heavier and less expensive oils can do so intelligently. The recommendations of the committee will be awaited with interest.

Foreign Trade After the War

As the prospects that the European War will soon come to a close grow brighter, there arises one question that more than any other is attracting the attention of the nations of the world, and that is: What of the great economic struggle that will surely take place after the cessation of hostilities? Steps have already been taken by many of the more important countries toward securing their share of the world's trade. In Europe this sentiment was expressed by the Allies Economic Conference, which convened in Paris to deal with conditions created by the war and to consider those that will exist after peace is declared. From Germany come rumors of similar trade agreements to insure her interest in the world's trade.

The ideas expressed at the convention of the National Trade Council, which was held in Pittsburgh, Penn., January 25 to 27, to discuss ways and means of developing a large foreign trade and the methods best suited to enable America to hold its own in world commerce once peace is declared in Europe, were gratifying and should be productive of lasting results.

Among the various suggestions advocated for accomplishing this end were better banking facilities, the development of our foreign exchange, the investment of capital in foreign countries, the upbuilding of an American merchant marine, the coöperation of governmental agencies and the departments of State with the end in view of negotiating advantageous commercial treaties, the collection and dissemination of information regarding foreign trade and suggesting improved financial and purchasing methods, and the removal of all doubt as to the application of the anti-trust laws to foreign trade by enacting the recommendations of the Federal Trade Council in respect to the Webb bill, which is now pending before Congress. The bill will permit American exporters to combine for the purpose of marketing agricultural and industrial products abroad, thus enabling them to meet the competition of combined foreign interests.

If this bill is enacted, and it is hoped that it will pass during the present session of Congress, there will come the real work of organization. Goods cannot be sold by the enactment of laws. The selling of products in our home market is a complicated problem, and success can be obtained only by the use of intelligent and efficient methods. If this is true in our home market, how much more true is it in the foreign markets of the world. The American manufacturer must coöperate in order to become educated in the many details entering into the selling of

goods abroad. The American business man has learned to do big things at home; he must now learn the larger task of doing similar things in the world's markets. Many American business men have been merchandising in foreign markets, but in the past this has in large part been carried on with competition among themselves. Nothing can be more destructive to American interests than the practice of competing with one another when selling abroad, for by so doing they are only playing into the hands of highly efficient foreign competitors.

After all is done, and we have the proper banking facilities and capital invested in foreign countries, the support of the government and a merchant marine, the results will still depend on the efficiency of the selling force that we place in the field. Germany became the power that she was in the world's trade before the war by the excellence of her salesmen. This is best expressed by a Spanish conception of the German commercial traveler recalled by Edward N. Hurley, chairman of the Federal Trade Commission, in addressing the convention.

The German traveling salesman, said Mr. Hurley, is one of the forces that have made German export trade what it is. He is pictured as a blond, spoon-eared, long-jawed individual. He is like a timid boy, who salutes like a recruit when addressing you but whose timidity does not prevent him from penetrating the remotest and most inaccessible parts of South America to sell the goods of Hamburg and Berlin. He travels on muleback, by canoe or afoot, sometimes carrying samples on his back like a peddler. He is a part of the romance of German industry; his glory is the order book. Wherever on the globe a handful of pioneers still battle with the forest and swamp, the tropical fevers and wild beasts, there the blond commercial traveler appears with his samples. He knows neither fatigue nor ridicule. His obscure triumphs are a part of the battle of modern commerce, and the world which he is capturing is for the glory and profits of the ledgers of Berlin and Bremen.

And that is the spirit in which American business men must go after foreign trade, continued Mr. Hurley. We can no longer regard the foreign market as a place for merely dumping our surplus goods, nor can we remain at home waiting for orders to come to us. The American merchant abroad, backed by a strong coöperative selling organization, must master the language and customs of the peoples to whom he sells, must cater to their moods and master foreign trade as a particular and highly important field for American business activity.

A New Central-Station Service

Central-station heating plants exist in many of the larger cities, and in some instances the steam has been used at relatively low pressures for power generation. However, distribution at high pressure for power purposes is a recent departure instituted by some of the more progressive steam companies and opens up an attractive field. The new steam plant described in this issue will furnish steam at one hundred twenty-five pounds to the lower section of New York in competition with both central-station service and isolated plants, as they now exist.

Whether the saving in boiler-room investment, coal, labor, etc., will overbalance the cost of purchased steam is a matter easily determined in each individual case. As far as competition with central-station electric service is concerned, the central steam plant has the advantage that the steam, after passing through the engines, can be used for heating and industrial purposes. The partial list of buildings in New York already using this service is indicative of the future possibilities.

Influence of Diversity in Load

The cost of power has been gradually decreasing while the cost of labor, coal and materials of every kind that go into the construction of the machinery and plant has been gradually increasing. Two of the big factors that have been responsible for lowering the cost of power are the vast increase in the efficiency due to improved construction and enlarged size of the machinery, and the decrease in the cost per unit capacity installed, which is largely the result of increased speed of the machinery brought about by the introduction of the turbine. There is a third factor that has had a very significant bearing on reducing the cost of power; namely, diversity of demand.

The first central stations supplied loads chiefly of lights and that for a short period in the evening only, which meant that the investment was earning only for a few hours per day while the cost of production was going on all the time. Consequently, the income from the few hours of operation had to be high enough to pay the expense of not only the period of operation, but also the idle period. Gradually the use for electricity became more diversified. Industrial-power loads and to some extent light and power for other purposes were obtained during the daytime and all-night lighting loads with, in some cases, power for other needs, and today many of the large central stations also supply railway loads—all from the same generators. Therefore, instead of the machinery being worked for a few hours per day, some of it at least is working all the time, thus continually earning income on the investment; consequently this income can be much less per unit output than when the load occurs for a few hours per day only.

However, few central stations are favored with a constant load. The peak of the industrial load will occur during the daytime, that of the railway load for a period in the morning and again early in the evening, the lighting load for the first part of the evening, etc. Since the maximum demands of the various customers of the different classes do not occur during the same hours, the machinery that is used to supply one class of service at one period may be used to supply other kinds of load at another; whereas, if the peaks occurred simultaneously, the plant would require capacity enough to supply the sum of all the maximum demands of the different customers. This diversity of demand is of great concern in planning the generating plant, substations and distribution systems. If it were not for the fact that the combined maximum demand imposed on an average central station is usually considerably less than half of the sum of all the maximum demands of the various customers, the investment involved to provide electric service would be much greater than that which is now required, therefore the cost of power would have to be increased. The importance of the diversity of demand upon power cost is shown by an article, "Diversity and Diversity Factors," in this issue.

Correspondence

Oiling Ammonia-Compressor Piston Rod

In the Dec. 26 *Power*, page 898, Mr. Warner's answer to W. J. Oettinger's request for information concerning the method used to circulate the oil used on an ammonia-compressor rod (which Mr. Warner described on page 695 of the Nov. 14 issue) is, I believe, incorrect for the reason that the displacement of the piston rod in the oil lantern is not varied at any point of its stroke. Therefore on the outward stroke oil could not be drawn from the bottom connection of the reservoir, and on the return stroke it could not be forced out of the top pipe as Mr. Warner believes—unless the rod is provided with a shoulder or taper. The shoulder or taper is not shown in the illustration, and for practical reasons it is very likely that the rod does not have them. Even should some means of varying the displacement have been provided, it would be of no value, as there is no check valve in the discharge line and the oil would only churn back and forth in the oil lantern and in the discharge pipe.

I believe the circulation of the oil is due entirely to the difference in weight of the two columns. The oil in the reservoir and lower connection being cool, overbalances the weight of the warm oil (heated by contact with the piston rod) in the discharge line and causes the circulation. I also believe that the system mentioned by Mr. Warner would work better without the check valve he has placed in the lower connection, as it is of no value and would have a tendency to retard the flow of oil through it, necessitating a greater temperature difference between the two columns of oil before circulation would occur.

Del Monte, Calif. A. C. McHugh.

Feed-Water Treatment Stops Boiler Pitting

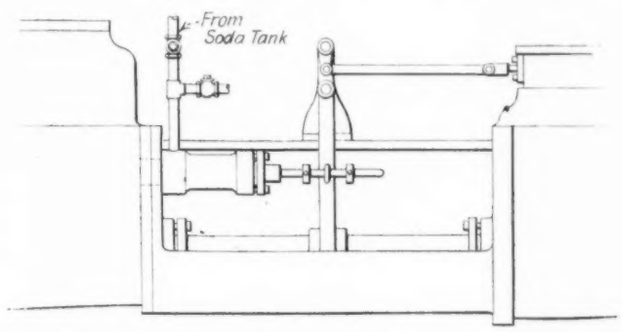
In the issue of Dec. 12 in the "Inquiries of General Interest," page 831, "F. M." asks for a treatment to stop pitting in steam boilers. I offer the following as the way we handle this proposition at our plant of six 250-hp. boilers of the horizontal return-tubular type.

We have driers using exhaust steam in the daytime and live steam at night. The condensation from these driers is returned to a vacuum pump, then to the heater and to the boilers. There is a cold-water spray in the suction line at the vacuum pump. This spray and all makeup water is taken from a well located alongside the coal-storage pile, and we believe this is what makes the water slightly acid, for after a heavy rainfall the water will turn blue litmus paper red, indicating the presence of acid.

After a boiler is washed, we put into it 14 lb. of soda ash dissolved in hot water, close it up and steam up. The water columns are blown down every morning and a sample of water taken. If it turns red litmus paper slightly blue the water is considered satisfactory.

We use four boilers at a time, and with the condensation from the driers we have little tube trouble from pitting when using 2 lb. of soda ash per 24 hr. for them all. With all raw water for feed, we are almost sure to have tube trouble.

If the water from the boiler fails to turn the red paper slightly blue, the amount of soda is increased until it comes back to normal again, taking care not to get too much, as it is apt to go over with the steam. The soda



BOILER COMPOUND FEEDER AS ATTACHED TO THE PUMP

is dissolved in hot water and put into a tank and is pumped into the open heater.

Before using soda ash, we had to take out leaky, pitted tubes almost every day, the tubes coming out very hard owing to the scale on them. Now they come out much easier, and we have run as long as six weeks without taking out a single tube.

The small pump for delivering the soda into the heater is home-made and, as shown, has two collars on the plunger rod so that the stroke can be regulated to pump fast or slow as desired. A steady feed gives the best results. This pump is arranged to attach to the boiler-feed pump and driven from the rod of a single pump or from an extension of the lever on a duplex pump. I hope these suggestions will help "F. M."

South River, N. J. John Morlock.

The Care of Electric Irons

Referring to the last part of W. G. Camp's letter on page 731 in the issue of Nov. 21 and the reply by J. E. Hudson in the issue of Dec. 19, 1916, page 858, I would suggest that if electric irons are installed in strict accordance with the National Electrical Code, they will be perfectly safe and there will be no burned hands or damaged sockets. The blowing of fuses is caused by the operator letting the iron get too hot. Single-pole switches should never be used in controlling circuits of more than 6 amp., or 660 watts, therefore all sadirons should have double-pole switches plainly indicating whether on or off and should be of the inclosed snap type.

A good job, for long life, calls for 20-amp. switches. Heavy sockets should be used, stamped 660-watts, 600-volts. Ordinary lamp sockets should never be used, and the keys should not be used to turn current on and off; they are not heavy enough to stand it. At least No. 16 reinforced lamp cord should be used. The six feet of cord next to iron should be special heater cord and stands should be provided for the irons when not in use. Each iron should have a double-pole fuse located in an accessible place. These must be of the approved inclosed plug or cartridge type. Judging from the description given this will call for a new lot of sockets, switches and lamp cord, but it will pay in the long run.

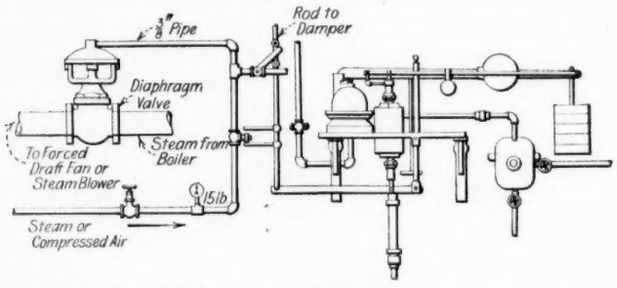
Educate the operators to keep the iron switched off or disconnected all the time that it is not in use; as long as it is in use, it will not get too hot. If they will watch this part, you will have no blown fuses. By disconnecting I mean either using the double-pole switch or pulling the connecting plug on the iron.

The National Electrical Code can be procured from the Underwriters' Laboratories, Chicago.[1] A copy should be in the hands of engineers who have wiring to look after, and the instructions should be closely followed.

Green Castle, Mo. J. GRYLE CAMPBELL.

Blower and Damper Regulator

The illustration shows a blowing-engine speed regulator, connected to a damper regulator, which was designed and installed by me and has been in operation for three years. This system is controlled by 15 lb. air pressure through ordinary gas-cocks, but steam may be employed instead by using steam-cocks. Its operation is as follows: When the damper regulator closes as in the



DAMPER REGULATOR CONTROLLING BLOWER AND DAMPER

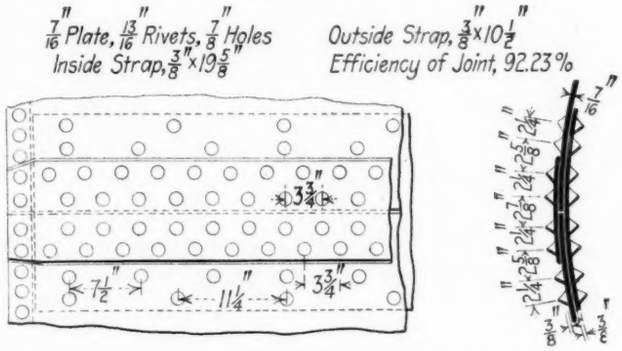
position shown, the lower plug-cock is opened by the lower tappet rod forcing the plug-cock lever upward, and at the same time the upper cock is closed in a similar manner, thus allowing pressure to act on the diaphragm valve controlling the forced-draft apparatus. When the damper regulator opens, the lower cock closes and the upper one opens, allowing the pressure to escape from the diaphragm to the atmosphere. The draft may be controlled to suit requirements by moving the tappet rods up or down on the damper rod or shifting the weights on the damper regulator. The pressure to be used depends on the area of the diaphragm and valve disk and also the steam pressure in the forced-draft line. A considerable saving in coal has resulted from the use of this siderable saving in coal has resulted with this regulator.

Springfield, Mass. CHARLES D. DYER.

[1]Also from National Board of Fire Underwriters, 76 William St., New York, and the Mutual Fire Insurance Co., 31 Milk St., Boston.

Proposed Quadruple-Riveted Butt and Double-Strap Joint

I desire to submit for discussion a quadruple joint, which is laid out to obviate the tendency of the inside strap to buckle and pull away from the sheet at the outer course of rivets. It is now the custom, I believe, to increase the thickness of the plate and straps when changing from a triple to a quadruple joint to overcome this



PROPOSED DESIGN OF QUADRUPLE-RIVETED JOINT

trouble. It seems possible to me that where a working pressure of suitable degree can be obtained with a joint efficiency of approximately 92 per cent., this form of joint would save one thirty-second of an inch in the shell thickness, which at the present price of plate material is well worth considering. It must, of course, be understood that this will apply only to cases where the minimum thickness of plate for certain diameters is not lessened. The question to be determined is, Will anything develop in the manufacturing of this joint to increase the cost from a shop viewpoint? W. A. MOFFAT.

Erie, Penn.

A Bell-Ringing Transformer Made from a Spark Coil

The article written by L. L. Newcomb, in the Oct. 31, 1916, issue of *Power*, describing a bell-ringing transformer made from a spark coil is not consistent with electrical theory. While the article is brief and to the point and there is no waste of words, I think that it ought to be more explicit to be understood.

First, Mr. Newcomb does not state what kind of a spark coil is to be used in the transformer construction, but as he speaks of the primary winding, it is to be supposed that a jump-spark coil is referred to. The primary winding of such a spark coil consists of a few hundred turns of No. 16 to No. 20 wire and the secondary of many thousand turns of about No. 36 wire. The primary winding of this coil is wound on the core and under the secondary, it would be troublesome to remove even a few turns, as the secondary winding would first have to be removed, which would be a tedious job.

Also, Mr. Newcomb does not tell how to connect this transformer to the source of supply, but one would suppose from the article that the current of supply (110 volts) is to be connected to the secondary of the coil; that is, considering the coil as being used for the purpose for which it was built—providing a spark for a jump-spark plug.

Taking the principle of alternating-current transformation the induced voltage will be in direct proportion to the number of turns in the primary and secondary coils. The primary voltage of the average jump-spark coil is 6 to 8 and the secondary around 10,000 to 20,000, therefore it will be seen that the ratio between the primary and secondary coils is from 1:1200 to 1:2500. If the coil is to be used as a bell-ringing transformer, the current of supply will have to be led to the winding of greatest number of turns, which will be the original secondary of the coil; and if this voltage is 110, then the electromotive force from the secondary or the original primary winding of the spark coil will be, at most, less than 0.1 volt and by no means enough to operate a bell. G. C. Long.

Lakeland, Fla.

[In referring to the primary, it is evident that Mr. Newcomb had in mind the transformer primary; this was the secondary winding of the spark coil before the change was made, consequently the layers of winding that were removed were taken from the outside of the coil. Furthermore, the secondary voltage of the transformer was not claimed to be 6 or 8 volts, as Mr. Long has assumed for the spark-coil primary voltage, but 1.5 volts. Considering the scheme in this light, it does not seem to be at all impossible.—Editor.]

In reading the remarks of L. L. Newcomb in *Power* of Oct. 31, 1916, on making a bell-ringing transformer from a spark coil, I am prompted to recount a recent experience of my own, which awakened a realization of the possible danger from these bell-ringing and so-called toy transformers in the hands of the uninitiated. These transformers are so small and supposed to be for such low voltage and are so inexpensive that no one ever considers them dangerous, but they may be, nevertheless.

Some time ago I had occasion to purchase by catalog, with other electrical toys, a toy transformer which was for 110 to 3 to 24 volts in steps of three volts on the low side, made possible by a small dial switch. When the transformer arrived, it was found that both the terminals for the 110- and the 24-volt coils were exposed so that a shock could be received. The primary, or 110-volt winding, was not conspicuously marked; in fact, it was necessary to search before it could be identified from the low-voltage winding. For those familiar with electrical equipment it was possible to determine the 110-volt winding, but for the average persons not accustomed to handling apparatus and being particularly careful, it is problematical whether or not they would have connected the proper winding to the 110-volt circuit.

To determine just the effect of making a mistake and operating the transformer inverted—that is, stepping up the voltage instead of stepping down—I connected the 3-volt coil across the 110-volt circuit and measured the voltage induced in the 110-volt coil. This was greater than 2000 volts, and through a low resistance the current was found to be more than 0.4 amp. instantaneous. Both current and voltage are more than sufficient to prove fatal in the majority of cases. This transformer was tested from a house circuit, which the Electric Code specifies shall carry a load not in excess of 660 watts per circuit. In many instances the fuses are chosen so that loads in excess of this may be carried. While testing the transformer in this way, the fuse blew, but it requires less time to receive a shock than to take measurements.

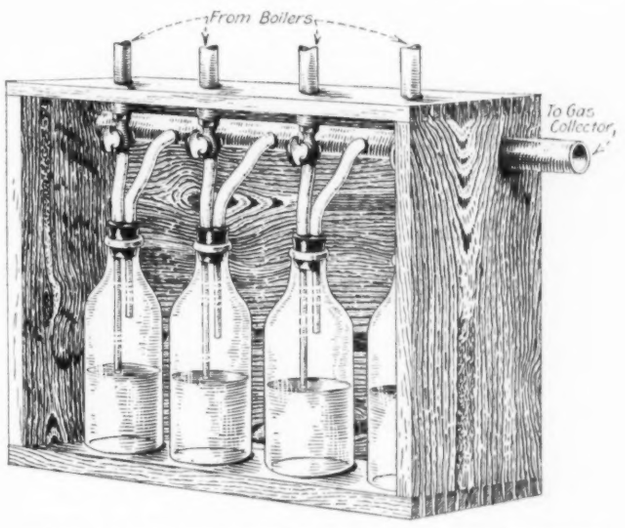
There is only one conclusion to be drawn from the occurrence related; namely, that these toy or small transformers may be a menace in the hands of persons ignorant in matters electrical. About the only way to make such a device comparatively safe is to design it so that it cannot be connected in any way other than that for which it was devised. M. A. Walker.

Chicago, Ill.

Visible Flow of Gas to CO_2 Recorder

The illustration shows an arrangement by means of which the flow of gas from each boiler of a battery delivering flue gas to a CO_2 recorder may be observed. This apparatus has been in constant use for more than a year and has proved satisfactory.

It had previously been the practice to have the recorder operate on each boiler separately for periods of one day in rotation. It was observed, however, that the firemen



FLOW OF GAS EQUALIZED BY OBSERVING BUBBLES

would adjust the draft conditions to show about 15 per cent. carbon dioxide on the boiler on which the recorder was working and would seldom disturb this adjustment during the day. As more or less steam was required, the other boilers were made to accommodate such conditions. It was soon found that we were getting first-rate CO_2 records from the boiler on which the recorder was working, but not from the others.

After the visible-flow apparatus was installed, it was at first found more difficult to obtain such a high percentage of CO_2 when supplying part of the gas from four boilers than when all gas was supplied from one boiler. At times one boiler would get too much air and the recorder would indicate a decided drop, and it was up to the firemen to locate the trouble. This gave them just the kind of training necessary to secure the best results. The present records show a high percentage of CO_2 from all four boilers working on one recorder, crude oil being used as fuel.

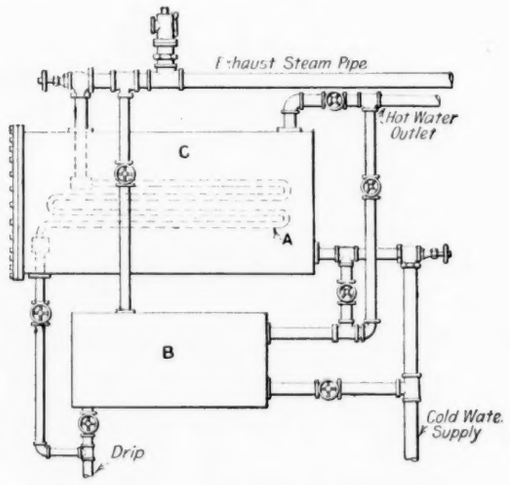
This apparatus can be installed at a cost of only a few dollars and consists of four bottles with rubber stoppers through which holes are punched to insert the ¼-in. glass tubes, rubber tubing being used for connecting the receiving pipes with the gas header through the water bottles. The flow of gas is regulated by observing the

bubbles and adjusting the cocks above the bottles. The long glass tubes should not be submerged more than 1/8 in. in the water, as this will very readily show the flow of gas. A small air-hose connection is used for blowing air back into the stack connection once a day just after the steam soot blowers have been used on the boiler tubes, to keep the small pipes clear.

Houston, Texas. PAUL MCINTIRE.

Combined Water Heaters

The illustration shows a water-heating system a little out of the common. Heater *B*, fired with coal, has a 4-in. water inlet and outlet, and *C* is a combined heater and storage tank having a steam coil inside; and both supply



TWO HEATERS CONNECTED TOGETHER

and outlet pipes are valved so the heaters can be used together or separately as desired. When first put into use, the system gave satisfactory results, but after some months the water failed to reach the usual high temperature. After spending considerable time examining the valves, etc., I disconnected the trap (not shown) attached to the drip and found that there was a large amount of water flowing through. On opening heater *C*, I found one of the return bends, at *A*, had a piece about the size of a quarter broken out. When this was repaired, the system worked satisfactorily again.

Kingston, Ont., Canada. JAMES E. NOBLE.

An Operator's Oversight

The following incident may save somebody else from getting into trouble from the same cause. About seven miles from the central station we have a substation that supplies a trolley line with 550-volt direct current from a 300-kw. rotary converter which is fed by a 11,000-volt three-phase line from the central station. We also have a 500-kw. rotary converter at the central station feeding the same trolley line, with no circuit-breaker in the trolley line between the two rotaries. One Sunday morning a lineman 'phoned in that the men wanted the current cut off the 11,000-volt line to do some work on it. While the lineman was waiting at the telephone to be told when the 11,000-volt line was dead, I called the substation to tell them that the current was to be cut off. Failing to get them, I opened the oil switch on the high-tension line and reported it dead to the lineman. After calling the substation to explain why the current was cut off, I was informed that everything was running. I lost no time in ordering the direct-current machine circuit-breaker and alternating-current oil switch opened.

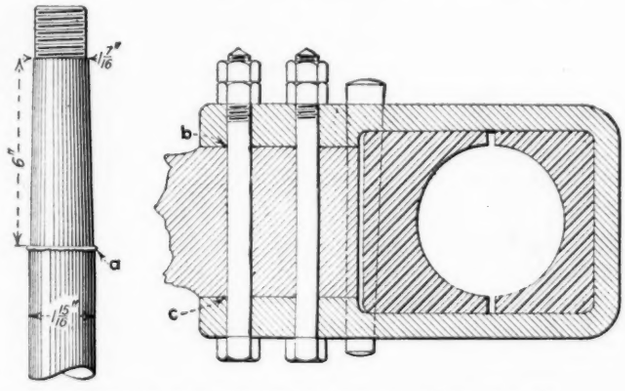
There were no cars out of the barn yet, and when the high tension was cut off, the rotary at the substation began taking direct current from the trolley and delivering alternating current back through the transformers to the high-tension line. Therefore, instead of the line being dead as reported to the lineman, there was probably 9000 or 10,000 volts on it. However, the line was cut off before anyone began working on it, consequently no one was hurt. H. A. NELSON.

Bangor, Me.

[There is nothing unusual about Mr. Nelson's experience; nevertheless it shows the necessity of being careful when making a line dead in a network, also that a workman should never go to work on a circuit until he has tested it to make sure that it is not alive when it is supposed to be dead.—Editor.]

Water in Engine Cylinder Caused Wreck

About two years ago an accident happened which might have been worse had not the design of the piston rod been of the best. The exhaust pipe formed a "pocket," or trap, and between Saturday afternoon and Monday morning water had accumulated in the pocket and the cylinder, and when the engine was turned over something had to go. The piston was put on the rod with a taper fit, but after it was removed from the cylinder, it could be turned on the rod by hand easily, although the nut had to be split to get it off. A shoulder, shown



DESIGN OF PISTON AND CONNECTING-ROD

at *a*, was upset about 1/32 in. Probably the water in the crank end had caused the rod to stretch in the taper and had jammed the nut on the thread, and on the return stroke toward the head end had jammed the piston on the rod hard enough to form the shoulder.

The crosshead end of the connecting-rod was made as shown, and the strain on the bolts on lines *b* and *c* had caused them to begin to shear but fortunately they did not let go. GEORGE B. LONGSTREET.

Tuft's College, Mass.

Inquiries of General Interest

Equalizing Lead of Corliss Engine—If the steam valves of a Corliss engine have the same amount of lap when the wrist-plate is in the central position but there is more lead on one end than the other how should it be equalized? P. M.

The difference can be corrected by changing the length of one of the connections from the wrist-plate to the valve arms. Shortening a connection reduces the lap and makes the lead earlier; or lengthening a connection makes the lead less.

Conversion of a Gasoline to a Natural-Gas Engine—How can a 4-cylinder gasoline engine be changed to one operated with natural gas? N. L. M.

The principal change would be to reduce the volume of cylinder-clearance space so as to obtain about 50 per cent. higher compression of the explosive mixture. It will be necessary also to provide a mixing chamber to replace the present gasoline carburetor.

Calculating Power from Piston Displacement—The volume of an engine cylinder is 8 cu.ft. and the m.e.p. 40 lb. per sq.in. What is the work done per stroke, and with the engine running 100 r.p.m. what would be the horsepower developed? W. D. H.

Understanding that the term volume is intended to refer to the volume of piston displacement per stroke, the work performed would be $8 \times 144 \times 40 = 46{,}080$ ft.-lb. per stroke. If the engine makes 100 r.p.m. and is double-acting, there would be a development of $46{,}080 \times 2 \times 100 = 9{,}216{,}000$ ft.-lb. per min., or $9{,}216{,}000 \div 33{,}000 = 279.27$ hp.

Lower Boiler Efficiency with Light Load—Why is a boiler less efficient when operated with a light load than when operated with a heavy load? S. D.

The principal reasons for less efficiency with a light load are: Larger proportion of cold air entering the fire-doors when stoking or cleaning fires; lower rate and lower temperature of combustion, resulting in less efficient absorption of heat by the boiler-heating surfaces; less perfect combustion of furnace gases and larger proportion of unburned fuel removed with the ashes; larger proportion of infiltration of cold air through walls and cracks of the boiler setting; larger proportion of heat wasted in discharged chimney gases; and larger percentage of heat lost by radiation from the boiler and setting.

Cleaning Oil from a Return-Tubular Boiler—How can oil deposits be cleaned from a 6x18-ft. return-tubular boiler that has become badly fouled from feeding the water returned from an exhaust-steam heating system? L. L. S.

Completely fill the boiler with clean water and add 25 to 50 lb. of soda ash and boil for 12 hr. under a gage pressure of 5 to 10 lb. After such a "cooking" the boiler and all valves and connections should be thoroughly cleaned, especially the steam stop, safety, feed and check valves and gage-cocks, as they are likely to become gummed up by the compound formed of the soda ash with the oil. Any hard or heavy deposits from oil in the bottom of the boiler, that are not taken up by the operation of boiling with soda ash, should be removed by scraping, for if allowed to remain they are likely to cause burning or bagging of the shell.

Operating Steam Pumps Expansively—Under what conditions can the stroke on the steam end of a pump be finished expansively? S. D.

As the resistance is practically constant for the full length of the stroke, to utilize the expansive force of the steam it is necessary to store up the excess energy that is developed during the first part of the stroke and replenish it during the remainder of the stroke by employment of a flywheel or mechanism known as a high-duty attachment. For use with two or more pistons operated expansively, equalizing gears have been designed with such forms of link connections that excess energy, developed before cutoff in one side of a duplex pump, is transmitted to the other side. From their complexity of design and restricted application these latter forms of compensating mechanism rarely have been employed.

Relation of Engine Economy to Exhaust-Steam Heating—In running a 50-kw. direct-connected high-speed engine supplied with steam at 75 lb. boiler pressure and using the exhaust for heating purposes, how would it affect the economy of the plant to increase the boiler pressure to 100 lb. gage? W. W.

For the same load and same back pressure from the heating apparatus, with a higher initial pressure the engine cutoff would be earlier and, under ordinary conditions, less fuel would be required for generation of steam supplied to the engine. Development of the same power would abstract the same amount of heat from the steam, and there would be less heat available from the exhaust. In case the improvement of engine economy is accompanied by a deficiency in the exhaust required for heating and that deficiency has to be made up with live steam, then increasing the initial pressure for improvement of cylinder economy would be of no benefit to the general economy of the plant.

Required Speed of Duplex Pump—A boiler is to be supplied with 10,000 lb. of water per hour by a duplex feed pump having a piston displacement of 0.04 cu.ft. per stroke, and the slip of the pump is 10 per cent. How many double strokes would the pump have to make to complete the delivery, and with a stroke 5½ in. what is the piston speed in feet per minute? H. N.

The volume of 10,000 lb. of feed water would be $10{,}000 \div 62.3 = 160.51$ cu.ft., and with a slippage of 10 per cent. and piston displacement of 0.04 cu.ft. per stroke, the delivery of 10,000 lb. of water would be completed by $160.51 \div (0.04 \times 0.90) = 4458.61$ single strokes or $4458.61 \div 2 = 2229.3$ double strokes. In each side of a duplex pump there are as many single strokes as the total number of double strokes made by the pump, and with a length of stroke of 5.5 in. and 2229.3 single strokes per hour by each piston, the piston speed would be $(2229.3 \times \frac{5.5}{12}) \div 60 = 17.02$ ft. per min.

Chimney Draft—Why does a chimney make a draft? F. P. C.

The force that drives warm air or gases up the flue is the force of gravity, being the excess of gravity or weight of a column of air of the surrounding atmosphere over a precisely similar column of the warm or expanded air or gas of less density in the flue. The action is the same as buoyancy imparted to a body immersed in a liquid or buoying up of air bubbles released below the surface of a liquid. An experiment illustrative of the action of gravity in the production of chimney draft can be made by filling a gage-glass tube with oil, and with the ends of the tube closed by pressure of the fingers, immersing the tube in water in a vertical position. Then, upon uncovering both ends of the tube, the oil is discharged upward out of the tube as the pressure of the water at the foot of the tube, due to gravity, is greater than the gravity of the oil within the tube plus the superimposed pressure of water above the upper end of the tube.

Setting Lead of Corliss Valves—In a Corliss engine with the eccentric and rocker plumb and the same amount of lap of each steam valve when the wristplate is in its central position, how are the valves set to give the correct amount of lead? P. M.

Place the engine on the dead-center—for instance, with the piston in the head end of the cylinder—hook in the wrist-plate reach rod and have an assistant slowly turn the eccentric around the shaft, in the direction the engine is to run, until the lap of the steam valve on the head end is taken up, as indicated by the marks on the valve and the valve chamber coming line and line. Then have the eccentric farther advanced and fasten it to the shaft when the proper amount of lead is obtained. The proper lead opening will vary from $\frac{1}{32}$ in. for engines having cylinders up to 22 in. diameter, to $\frac{3}{64}$ in. for cylinders 22 to 30 in. diameter. When the eccentric has been secured to the shaft, turn the engine on the other dead center and observe whether the same amount of lead is obtained on the other end. The probabilities are that it will not be exactly the same, but if other parts of the valve setting have been carefully done, the discrepancy can be corrected by making a small change in the length of one of the rods that connect the valve arms with the wristplate. The exact setting should be determined by taking indicator diagrams.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Investigation of Suspension Insulator Deterioration*

By J. E. Woodbridge

The trouble experienced by operators of high-voltage transmission lines, due to deterioration with age of the dielectric strength of cemented porcelain suspension insulators, combined with the inability of ceramists and engineers to agree upon a satisfactory explanation of such deterioration, has induced the power companies of California to join forces in a scientific investigation of this deterioration. The results of this study in so far as results have been obtained to date are represented in full in the papers presented by Prof. Harris J. Ryan and Assistant Prof. J. C. Clark before the San Francisco section of the A. I. E. E., Nov. 16, 1916. The companies interested in this investigation to the extent of contributing to its expense are: The Pacific Gas and Electric Co., Pacific Light and Power Corporation, Sierra & San Francisco Power Co., San Joaquin Light and Power Corporation and the Southern California Edison Co.

The investigation began as the outcome of discussions on the subject between J. P. Jollyman, of the Pacific Gas and Electric Co.; H. A. Barrie, of the Pacific Light and Power Corporation, and the writer, representing the Sierra & San Francisco Power Co. These discussions resulted in a conviction that megohm values of infinity determined by the commercial megger—that is, anything above 2000 or 5000 meggers—covered a wide range of porcelain values, an investigation of which might develop insulation resistances characteristic of durable versus nondurable porcelain. It was even thought that if deterioration was due to porosity and a suitable apparatus could be developed for measuring much higher insulation resistances, a characteristic resistance might be found for porous porcelain, even when dry. It is obvious that if these hypotheses had proved correct, it would be possible for insulator makers to measure by electrical means such porosity in new porcelain, and determine in advance what insulators would deteriorate.

It was also the idea of these engineers that insulation-resistance measurements made under dielectric stresses more nearly approximating those of commercial service than the 1000 volts of the commercial megger might be of correspondingly greater value.

The inherent difficulties of such measurements with alternating voltages, due to the extremely low power factor of insulator leakage, at once suggested the use of the kenotron for the supply of continuous current at the voltage desired.

A paper presented by Professor Ryan before the San Francisco section of the A. I. E. E., Mar. 31, 1916, described such measurements made at Stanford University, under a pressure of 4000 volts, direct current, derived from a kenotron, with a sensitive galvanometer, the combination giving a range up to 800,000 megohms distinguishable from infinity. This equipment, as then developed by Professor Ryan, obviously extended the range of meggering to values 160 times greater than those of the commercial megger. A further extension of this line of investigation was then proposed by Professor Ryan, with the request that he obtain the consent of the university authorities for the use of their high-tension laboratory and its equipment for this study during the 1916 summer vacation. Professor Ryan obtained this privilege and agreed to serve as a member of the committee having charge of the work, to which service he devoted the greater portion of his time during the vacation period. The necessary funds were contributed by the companies mentioned, and the work was started under the direction of Professor Ryan, the engineers previously named and Assistant Prof. J. C. Clark, who was employed actively on the work with assistance throughout the summer. Insulators were contributed by the various power companies mentioned and by the Great Western Power Co., also by several manufacturers, usually in lots of 100, these insulators being of all the well-known makes and in so far as possible of average ages, color and previous condition of servitude.

The result of this investigation to date may at the outset be admitted to be disappointing, as the ambitions of the promoting engineers have not been realized. Water-logged elements have been dried out and restored to insulation resistance equal to those of the least porous. By the use of continuous current at 25,000 volts and of galvanometers of great sensitiveness, infinity has been thrown above the resistance of any single piece of porcelain procurable, measurements being possible up to 10,000,000 megohms. As might be expected, this has been accomplished only by the exercise of great care and ingenuity in the matter of guarding against leaks. The characteristic resistances of porcelain suspension insulators of common shapes and sizes have been found to run between 250,000 and 1,750,000 megohms.

Conclusive positive information on the cause of deterioration has not been obtained, but considerable negative information has practically eliminated several causes previously considered probable. Mechanical loads have been proved to have little or nothing to do with the case. Stresses set up by expansion and contraction with temperature changes appear to have little or nothing to do with deterioration in properly designed and annealed elements. There are indications that these stresses are as great in insulators without attached hardware as in those complete with cemented metallic attachments; also, that such stresses are as great in porous insulators as in those more thoroughly vitrified.

A study of porosity has shown that much, if not all, wet-process electrical porcelain is slightly porous, some of this porcelain being more suitable for filtration use than for the exclusion of moisture. Aside from this exception the term "slightly porous" here means porous to such an extent that moisture may, in the course of years, creep into minute crevices, forming conducting paths, which eventually reduce the distance between terminals of the insulator (considering such paths as conducting extensions of terminals into the mass of the porcelain) until the dielectric stress between terminals will rupture the intervening material. Local heating in the nonporous barriers separating such conducting paths probably assists the final failure of the remaining dielectric strength. This investigation has shown that porcelain has an extremely high negative rate of change of resistance with temperature. Of the specimens tested, the rate of change may be stated as a loss of 99 per cent. of the resistance with a rise of 45 deg. C. for ordinary temperatures.

This partial porosity has so far been found extremely difficult of detection. We have found it impossible to devise any means of materially hastening the absorption of moisture above the rate inherent in ordinary line use, which often requires several years before the deterioration is apparent.

The difficulty in making porcelain bodies absolutely impervious to moisture is obviously due to the fact that porcelain by the very nature of its formation cannot be completely liquefied in the process of vitrification as can other materials, such as glass. This leads to the consideration of materials having the desired mechanical and electrical qualities, which can be liquefied and cast in a mold. Of these the most promising in both electrical and mechanical characteristics that has been brought to the attention of the committee is fused silica. This material has a high dielectric strength and an extremely low coefficient of expansion with temperature. Its behavior when subjected to high dielectric stresses of sustained high frequency gives promise of very desirable characteristics in the qualities of dielectric strength, local heating under high potentials and change of resistance with temperature.

It is the wish of the committee that others investigating this subject or in a position to do so may benefit by the ideas developed by this committee's work to date and may carry on the work along the various lines indicated, which this committee has not been in a position to carry to completion.

*From paper at San Francisco meeting, A. I. E. E., Nov. 24, 1916.

Results of the Government's Tests on Gasoline

The Bureau of Mines has just completed a thorough report by W. F. Rittman[1] upon the physical and chemical properties of gasoline, of which this is an authorized digest. The object of the investigation by the bureau has been to serve the public impartially in an educational way and not to emphasize the advantages or disadvantages of any variety of gasoline. The data obtained show the properties of a number of products which were representative of commercial conditions throughout the country during the calendar year 1915. The analyses in themselves are of considerable importance and are of use in showing how similar tests may be generally applied and interpretation made to fit the specific needs of producers and consumers.

The bulk of the results of this investigation goes to show that there are possibilities of wide variation in the properties of gasolines and that a product bearing this name cannot be defined as exactly as might be expected. However, by noting certain properties or relations between properties, it is possible to discover with some accuracy the source, method of production and possible utility of the products examined.

The highest-priced grade, called 76-deg. gasoline, is as light as it is practicable to use, dangers in handling and

[1]Chemist, United States Bureau of Mines.

evaporation losses being considered. Such gasoline really has a specific gravity of 73 to 74 deg. Bé., the 76-deg. figure being a trade rating which is not attained in actual practice. The other and cheaper grades of gasoline are sometimes rated according to gravity and are sometimes classed as auto or motor gasoline. Grading according to specific gravity was of some significance in the past, but at the present means nothing unless information is at hand regarding several other details.

In collecting samples the use of a uniform method of sampling was impracticable because of the necessity of obtaining gasolines representative of all the important markets of the country. The method of sampling that seemed most desirable was to purchase directly from retailers and thus obtain gasoline identical with what the average consumer could obtain. In the Pittsburgh and San Francisco districts this method was adopted, representatives of the bureau making actual purchases from filling stations. Gasolines from the other fields were obtained direct from refiners, and the investigation showed that the characteristic differences between samples of gasoline are so great as to make the changes due to storage and transfer from containers relatively unimportant.

In order to discuss the results obtained, the data for each series of analytical tests are considered under seperate heads, and subheads are employed to differentiate indications obtained in regard to source or method of manufacture of products.

Specific gravity is the property that is almost invariably measured in the commercial grading of gasolines. Most of the samples obtained have gravities between the limits of 55 and 75 deg. Bé. (specific gravities of 0.758 to 0.864). In general, the Eastern gasolines are lightest, their gravities ranging between 60 and 75 deg. Bé. (0.737 to 0.683). Products from the Mid-Continent fields fall mostly between the limits of 59 and 63 deg. Bé. (0.741 to 0.707), and those from California between 57 and 63 deg. Bé. (0.749 to 0.725).

COMMERCIAL VALUE OF A GASOLINE

The most important property in determining the utility and commercial value of a gasoline is that of volatility, indicated in the laboratory by the distillation range. Gasoline, like all petroleum products, is a complex mixture of a number of hydro-carbons, these varying in proportion and having different boiling points. Owing to this fact, the possibility of variation in the composition of products commercially classed as gasoline is practically infinite, and all that is possible in determining properties and constituents is to indicate limiting values. Thus, for example, we may say that a high-grade "straight" refinery Pennsylvania gasoline is made up of constituents of which 10 per cent. boil below 50 deg. C. and 85 per cent. between the limits of 50 deg. and 125 deg. C. A blended casing-head gasoline of apparently the same grade, commercially speaking, might have 30 per cent. boiling below 50 deg. C. and would contain a considerable proportion of constituents having boiling points ranging up to 200 deg. C. Analyses furnishing information of this sort are useful for the study of the properties of gasolines, but it should be definitely understood that they are not analyses for individual chemical compounds. These are generally possible only through a relatively large amount of work and are of little practical value.

A number of engine tests of typical gasolines were made with special care and accuracy, the average probable error being about 3 per cent. The amount of power developed by the different samples did not at the most differ more than 10 per cent. The average difference on either side of the mean was found by calculation to be only 2.1 per cent.

All gasolines can, under properly regulated engine conditions, be made to develop about the same amount of power. This result indicates that the claims made by many refiners for the superior power-producing qualities of their gasolines are largely without foundation. It does not necessarily follow that all gasolines are equally good, but it is certain that in some instances exaggerated claims are made for the number of miles obtainable from a gallon. The possible element of superiority undoubtedly lies in some products giving maximum efficiency over a wider range of engine conditions, such products consequently being more nearly "foolproof" and weatherproof.

The important fact is, therefore, that if the user of gasoline takes suitable care of his engine, he can get almost as good results out of a cheap gasoline as out of expensive high-test products. It is interesting to note that many owners of automobiles have already discovered that a high-test gasoline is not necessary and that they are able to get efficient service out of home-made blends of gasoline and kerosene. On the other hand, those who use engines not suitably constructed or find it undesirable or inconvenient to make the necessary adjustments, may justly claim that high-test gasolines are worth the prices paid for them.

In this investigation it was not found possible to include a comprehensive series of experiments showing how the physical and chemical properties of a gasoline control its action in an automobile engine. However, certain indications obtainable from the results given are of value in indicating how specifications may be drawn for the purchase and sale of gasoline. In this connection, the following facts are of interest:

1. The two properties of a gasoline that tend to make its cost high are (a) a narrow range of boilings points and (b) freedom from unsaturated constituents. These properties are possessed by the so-called high-test gasolines, which have gravities of 70 to 74 deg. Bé. and are obtained by straight distillation processes.

2. It is evident that the first factor of expense is one that can be efficiently minimized. The results of the engine tests made show that the high-test gasolines were slightly, if at all, superior to the cheaper products as regards power development, and then only on a weight basis. As gasoline is sold by volume, the actual rating runs the other way. The chief element of advantage seems to be that the high-test gasolines yield maximum efficiency over a larger range of engine conditions. The newer designs in engine construction have largely tended toward making possible the use of gasolines that are more difficult to vaporize. In any event, proper care and adjustment of an engine makes unnecessary the employment of a high-test gasoline. It appears, therefore, that the user need not purchase the more expensive lighter grades if the engine is efficient in design and if the operator is moderately skillful and careful. Heavy-gravity refinery gasolines, cracked gasolines and blended casing-head products are now being used in enormous quantities and, as far as can be judged from the absence of complaints regarding them, they are giving satisfactory results.

From the same indications it appears that a high degree of saturation is as unnecessary as narrow boiling range. There are on the market large quantities of cracked gasolines having iodine numbers up to 60, and the content of unsaturated compounds seems to cause the users no inconvenience. It is probable that by suitable adjustment of conditions, especially as regards setting the carburetor to produce a "lean" mixture in the engine, products of even higher degree of unsaturation may be used. The present market products are apparently so refined and blended that their characteristic properties do not even attract attention.

A minor fact that deserves mention is the undesirability of attempting to use "motor" gasoline either as a cleaning fluid or as a drying solvent. This is shown by the high boiling points of some of the constituents in many of the gasolines tested.

To summarize the matter of gasoline specifications, it may be said that the conditions under which the gasoline is to be used should be considered and then requirements should be outlined for as cheap a motor fuel as can be consumed with approximate maximum efficiency. If engine conditions are adjusted to attain this condition, a cheap gasoline will yield as much, or even more, power than the lighter and more expensive high-test products. In addition, the results indicate that both cracked and blended gasolines may be utilized to as great advantage as straight refinery products.

Developments in Power-Plant Practice

At the annual meeting of the Indiana Engineering Society, held at Purdue University, Lafayette, Ind., Jan. 18 and 19, the power-plant committee headed by George W. Hubley summarized briefly the important developments of the last year. Under "Turbines" reference was made to the three-element 60,000-kw. units to be installed in New York City and to the single-element turbine of 45,000-kw. capacity being built for the Detroit Edison Co. Steam pressures for the large units ranged from 230 to 275 lb., and the superheat from 200 to 275 deg. F. On a 30,000-kw. unit of the Interborough Rapid Transit Co. a water rate of 11.25 lb. per kilowatt-hour with a thermal efficiency of 24.81 per cent. has been obtained. The highest economy for the year was reported for a 20,000-kw. unit, taking steam at 275 lb. pressure and 275 deg. of superheat. Under test the water rate per kilowatt-hour was 10.2 lb. Reference was also made to the long-period economy test conducted by the Detroit Edison Co., which showed an average consumption of 1.45 lb. of coal per kilowatt-hour, the calorific value of the coal being 13,606 B.t.u. per lb. and the average load factor 66 per cent. It was pointed out that the results previously given should not be taken as existing standard performance of the average plant, but rather as an indication of what may be expected in the future, inasmuch as only a few exceptional cases of new large plants recently constructed have attained such economies.

In boilers there have been no special developments, but much attention has been given to improving conditions effecting economic operation. Large units ranging from 12,000 to 25,000 sq.ft. of heating surface have been installed in a number of plants under conditions of steam pressures of 225 to 275 lb. and superheat as high as 275 deg. F.

Reference was made to a number of improved types of stokers that have been placed on the market, and especially those operating on the underfeed principle. The advantages of the latter type of stoker were enumerated, and its successful operation with Indiana and Kentucky coals was mentioned.

A suggestion offered by J. F. O. Stratton that boiler and furnace efficiency be separated was approved by the committee and considered desirable if it could be made practicable. Such procedure would separate the responsibilities of the boiler and stoker manufacturers. It could be accomplished if in the boiler specifications were included certain specified conditions of furnace requirements, such as guaranteeing an evaporation of — lb. of water when the gases from the furnace are of sufficient volume to maintain a temperature of — deg. F. at the beginning of the first pass and that the gases do not contain less than — per cent. of CO_2 nor more than — per cent. of CO. Further, that the temperature of the gas at the entrance of the breeching will not exceed -- deg. F. under such conditions.

In the opinion of the committee the economizer is of doubtful value in localities where bituminous coal could be obtained at reasonable prices. The steady increase of evaporation due to larger grate surface and more draft, resulting in more heat available for recovery, makes economizers more desirable, especially when the tendency to use motor-driven auxiliaries and the lower hotwell temperatures due to recent improvements in condensing apparatus are considered.

The importance of a full complement of instruments for checking and recording plant performance was emphasized. Instruments are particularly necessary to cope with the new problems presented with the installation of large boilers and underfeed stokers. Instruments considered essential in the larger plants are steam-flow meters equipped with indicating, recording and integrating attachments; thermometers to indicate the temperature of the gases in the boiler uptake, the temperature of the feed-water, etc.; CO_2 recorders to indicate combustion conditions in the furnace; draft gages to indicate drafts in the furnace and uptake; pressure gages to indicate pressures in the individual boilers and in the header; indicating wattmeters to show the output of the turbo-generators; and other electrical instruments such as are usually installed. The use of all of these instruments may not be justified in the smaller plants.

LARGE CONDENSERS AND HIGH VACUUM

In condensers great improvements have been made in the design to provide unrestricted steam passages by eliminating faulty arrangement of baffling. Vacuums as low as 29.64 in., referred to a 30-in. barometer, have been obtained in modern condensers. A 50,000-sq.ft. condenser of the New York Edison Co., under test, showed a vacuum of 29.25 in. with a hotwell temperature of 69.5 deg. F.

Since it has been considered good practice to provide forced ventilation for all large generators, the development of the air washer has been rapid. The basis of requirements for air to adequately keep the temperature within practical limits is from 3 to 5 cu.ft. per min. for each kilovolt-ampere output.

Much of the preceding relates especially to large-sized central-station installations. In prime movers for the smaller and medium-sized light and power plants there has been development. The advent of the geared turbine with several nozzles for different loads and refinements and increased economies in other types of turbine have given an impetus to reciprocating-engine designs, resulting in the uniflow and steam-jacketed poppet-valve engines which give good economies under variable conditions. During the year a large number of plants have been redesigned and have shown marked increase in economy of operation over the older systems. A number of small municipal plants have also been remodeled to utilize the exhaust steam from the power plant for heating public schools and buildings, including the courthouse, city hall, etc.

For the gas engine there are possibilities in connection with the now-wasted byproducts in sewage and garbage-disposal and the waste gases from furnaces and ovens in metallurgical work. The low cost of power from gas-producer plants should not be overlooked.

As a whole the water-works field has progressed. More attention is being given to the engineering features, resulting in greater economy in construction, better service and a comparatively lower operating cost. Ten years ago pumping machinery had become more or less standardized and the same type of pump was used regardless of the character or condition of the service. Today it is realized that each plant presents its own individual problem. For example, there are installations especially designed for deep-well pumping, others for low-head pumping from surface supplies, and then there are the requirements of a municipality in domestic and fire service. Generally speaking, the greatest progress has been made in the turbine centrifugal pump, which is now used for both high- and low-head service and for small and large capacities. During the last 10 years several units of this type have been installed having a delivery of 100,000,000 gal. per day of 24 hr. and comparing favorably in duty with the triple-expansion pumping engines. Generally, the centrifugal has the advantage of low cost and of being especially adapted for emergency conditions.

Pennsylvania Boiler Safety Standards

Charles H. Garlick, state steam boiler inspector for Allegheny County, Pennsylvania, is sending out the following:

This office respectfully recommends that every boiler owner in Allegheny County provide himself with a copy of the Safety Standards of the Industrial Board of Pennsylvania on boilers, which can be procured from the Department of Labor and Industry, Harrisburg.

The law provides that all boiler rooms shall have a sufficient exit for employees, in case of an accident occurring to the boilers. A safe exit from a boiler room should be at least two doors, two stairways, two fixed ladders or any other two safe means of exit. Horizontal and water-tube boilers shall have foot-walks for each boiler or battery of boilers. There shall be a permanent stairway or ladder to said foot-walk. All water gages shall be so protected that in the event of their breaking, the employee cannot be injured.

Section 293 of the Safety Standard provides "That each boiler shall have three or more gage-cocks located within the visible length of the water-glass, except when such boiler has two water-glasses with independent connections to the boiler and located on the same horizontal line, and not less than 2 ft. apart."

Article 277 provides "That safety valve or valves shall be connected to the boiler, independent of any other steam connection, and attached as close as possible to the boiler without unnecessary intervening pipe or fitting. Every safety valve shall be connected so as to stand in an upright position, with the spindle vertical when possible." When a discharge pipe is used, it shall not be less than the full size of the valve, and the discharge pipe shall be fitted with an open drain to prevent water lodging in the upper part of the safety valve or in the pipe.

Section 279 provides, "All safety-valve discharges shall be so located or piped as to be carried clear from running boards or working platforms used in controlling the main stop valves of boilers or steam headers."

Section 311 provides, "A bottom blowoff pipe when exposed to direct furnace heat shall be protected by firebrick, a substantial cast-iron removable sleeve or a cover of nonconducting material."

Section 312 provides, "An opening in the boiler setting for a blowoff pipe shall be arranged to provide for free expansion and contraction." The regulations set forth by the Safety Standard must be complied with.

Vapor Pressure of Various Compounds at Low Temperatures

G. A. Burrell and I. W. Robertson, of the Bureau of Mines, in their work on the condensation of the constituents in natural gas, and in studying the separation of gas mixtures by fractional distillation, made vapor-pressure measurements of gases at low temperatures. Among the compounds for which the pressures at such temperatures either had not been determined, or had been determined only within limited ranges of temperature, were ethylene, propylene, isobuthylene, ethane, propane, isobutane, sulphur-dioxide, nitrous dioxide, ammonia and acetylene. Technical Paper 142, of the Department of the Interior, contains a report of their investigations of the subject. The paper describes the apparatus used and the manner in which the samples were prepared. Tables are given of the observed and calculated pressures of the gases named, the pressures being all subatmospheric and in most cases extending to 1 mm. of mercury. Pressures were calculated by Nernst's empirical formula, the constants being determined from the observed values. These constants and the formulas connecting the pressure and temperature, and pressure-temperature curves, are given for all the gases. The reciprocal of the absolute temperature plotted against the common logarithm of the pressure gives a straight line.

NEW PUBLICATIONS

ELEMENTARY CAMS. By Franklin De Ronde Furman. John Wiley & Sons, Inc., New York City. Cloth; 90 pages; 5¾x9 in.; 69 illustrations; indexed. Price, $1.25.

The author in his preface points out very properly that there is a sharp contrast between the development of the gear and the cam. Articles in technical journals and numerous books have dealt with the former, but little has been written about the latter. Shop practice in regard to gears has been carried to a high degree of perfection. On the other hand, cams are too often designed "by eye" instead of being based upon an intelligent theory of their action. Thus this book on elementary cams has been prepared with a view to gathering together in permanent form information on the various types in common use and how to design a representative cam in each class. Most of the base curves in common use in cam design are described and their application pointed out. There are five chapters, or sections, with these headings: Definitions and Classification; Method of Construction of Base Curves in Common Use; Cam Problems and Exercise Problems; Timing and Interference of Cams; Cams for Reproducing Given Curves and Figures.

HANDBOOK ON WESTINGHOUSE WATT-HOUR METERS. Published by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. 1916. Cloth; 4½x6½; 114 pages; indexed; 99 illustrations.

The purpose of this handbook is to give complete technical information on Westinghouse watt-hour meters, but it is not intended for an instruction book on watt-hour meter testing. The work is divided into six chapters. Chapter I gives a brief description of the early development of the watt-hour meter. Chapter II is a detailed description of the various types of Westinghouse meters, including many tables giving the ampere capacity, numerical value of one revolution of the first dial hand, test constants, watt-hour constants, numerical value of register constants, register ratios and gear ratios of the different types of instruments. Chapter III is a brief outline on the use of test constants and formulas. The development and use of rotating standards is treated in Chapter IV. Chapter V points out some precautions to be observed in connecting up meters, and Chapter VI deals with the use of laboratory standards. The material in this book is presented in such a way as to make it readily understood by the practical man and should be of interest to everyone who has to do with Westinghouse watt-hour meters.

PERSONALS

H. L. Hansen has been appointed assistant treasurer of the Rutland Railway, Light and Power Co. He will make his home in Rutland, Vt.

D. P. Tierney has been appointed superintendent of the Sayre Electric Co., Sayre, Penn., with which he has been connected for the past eight years.

William J. DuBois, an old and active member of the Marine Engineers' Beneficial Association, was tendered a welcome-home dinner by 50 of his friends at the Elks' Club, Brooklyn, N. Y., on Thursday, Jan. 18.

S. F. Bond, who has been connected with the engineering department of W. S. Barstow & Co., Inc., for several years past, and who has been working for them on various properties, is now located at Binghamton, N. Y.

Byron T. Burt, for the past two years vice-president and general manager of the Rutland Railway, Light and Power Co. and allied interests in and near Rutland, Vt., has resigned to take a responsible position with another organization.

H. G. Brinckerhoff, formerly with the Green Fuel Economizer Co., and more recently manager of the Keystone Stoker Co. at Boston, is now with the Engineer Co., in charge of its work in the New England States, with offices at 10 High St., Boston, Mass.

P. A. Staples, vice-president and general manager of the Binghamton (N. Y.) Light, Heat and Power Co., has been appointed general manager of the Sayre Electric Co., Sayre, Penn., which position he will fill in connection with his duties at Binghamton.

F. S. Nicholson, for the past eight years vice-president and general manager of the Sayre Electric Co., Sayre, Penn., has been appointed to the same position with the Rutland (Vt.) Railway, Light and Power Co.. He will remain a vice-president of the Sayre property.

R. K. Stockwell, who has been chief engineer and superintendent of construction for the Braden Copper Co. at Rancagua, Chile, for the past five years, will soon open a Western engineering and sales office for the Robins Conveying Belt Co. in Salt Lake City, Utah.

Charles T. Bird, connected with the Pangborn Corporation some years ago as sales engineer, and for the last year with the Mott Sand-Blast Co., resigned Jan. 1, to become associated again with the Pangborn Corporation as vice-president and works manager, in charge of engineering and production.

ENGINEERING AFFAIRS

The Engineering Society of York, Penn., at its recent annual meeting, elected the following officers to serve for 1917: President, George A. Jessop; vice-president, Chauncey D. Bond; secretary, M. Haller Frey; treasurer, Harold A. Russel; directors, W. W. Birnstock, Griffith S. Amies, Harry W. Motter.

The American Electric Railway Association will hold its seventh annual midyear meeting and dinner at the Copley-Plaza Hotel, Boston, Mass., on Feb. 16. A fine program has been arranged, and the following speakers will make addresses at the dinner: Hon. S. W. McCall, governor of Massachusetts; Hon. W. G. Harding, United States Senator from Ohio; Hon. J. M. Curley, mayor of Boston; Hon. J. E. Hedges, of New York, with the president of the association, L. S. Storrs, presiding.

The Boston Sections of the A. I. E. E. and A. S. M. E. and the Boston Society of Civil Engineers will hold their eighth annual banquet at the Boston City Club on Wednesday evening, Feb. 7, at 6:15 o'clock. An exceptionally interesting and instructive program is being prepared, and all engineers, whether affiliated with any society or not, are cordially invited to attend. The speakers will include Prof. Elihu Thompson, consulting electrical engineer, General Electric Co.; Dr. Hugh Cabot, chief of Harvard Surgical Unit in France; and E. H. Ewertz, superintendent of the Fore River Shipbuilding Corporation, who will give an illustrated talk on submarines.

Government Nitrate Plant—The President has appointed a committee consisting of the Secretaries of Agriculture, War and the Interior, to select a site for the proposed Government nitrate plant, and several localities are competing for it, mostly in the South.

Nitrate Plant at La Grande, Wash.—The American Nitrogen Products Co., of Seattle, Wash., has started work on the erection of a plant for the fixation of atmospheric nitrogen, at La Grande, Wash. The initial development, it is reported, will cost $500,000. It is expected that the main development will be on the Sauk-Suiattle River, where the company is interested in a power site capable of developing 200,000 hp. The cost of the final development is to be $50,000,000.

Water Power in Uruguay—The President of Uruguay has submitted to the General Assembly a bill to provide for the government control of all watercourses, whether navigable or not, and all hydraulic power not yet utilized. Under the proposed law an irrigation commission would be in charge of all the projects for irrigation and hydraulic works, and the projects would be financed by an issue of government bonds to the amount of 1,551,000 at 6 per cent. and 1 per cent. accumulative amortization.—U. S. Commerce Report.

Use of Water Power of National Forests—In his annual report Henry S. Graves, Chief of the Forest Service, says that 20 new water-power projects that utilize National Forest land began operation in the fiscal year 1916, as against 12 in 1915. The Forest Service figures show that 42 per cent. of the total developed water-power plants of the United States utilize National Forest land. The development of relatively small projects is particularly in evidence in the Rocky Mountain states. California leads in the amount of power under permit and in operation. The number of transmission-line permits in effect was increased by 13 during the year. The 40 applications for power-project permits received in 1916 included 8 from Alaska—a notable evidence of increased local interest in power development there. The rate of increase in water-power development for public-service use from 1902 to 1912 was approximately three times as great as in steam power. Primary power installation from all sources and for all uses increased from 1902 to 1912 more than 2½ times as rapidly in the 11 Western States as in the remainder of the United States, while the increase for primary electric power for the same period was 440 per cent. for the Western States, as against 226 per cent. in the other states.

Annual Meeting of Marine Engineers

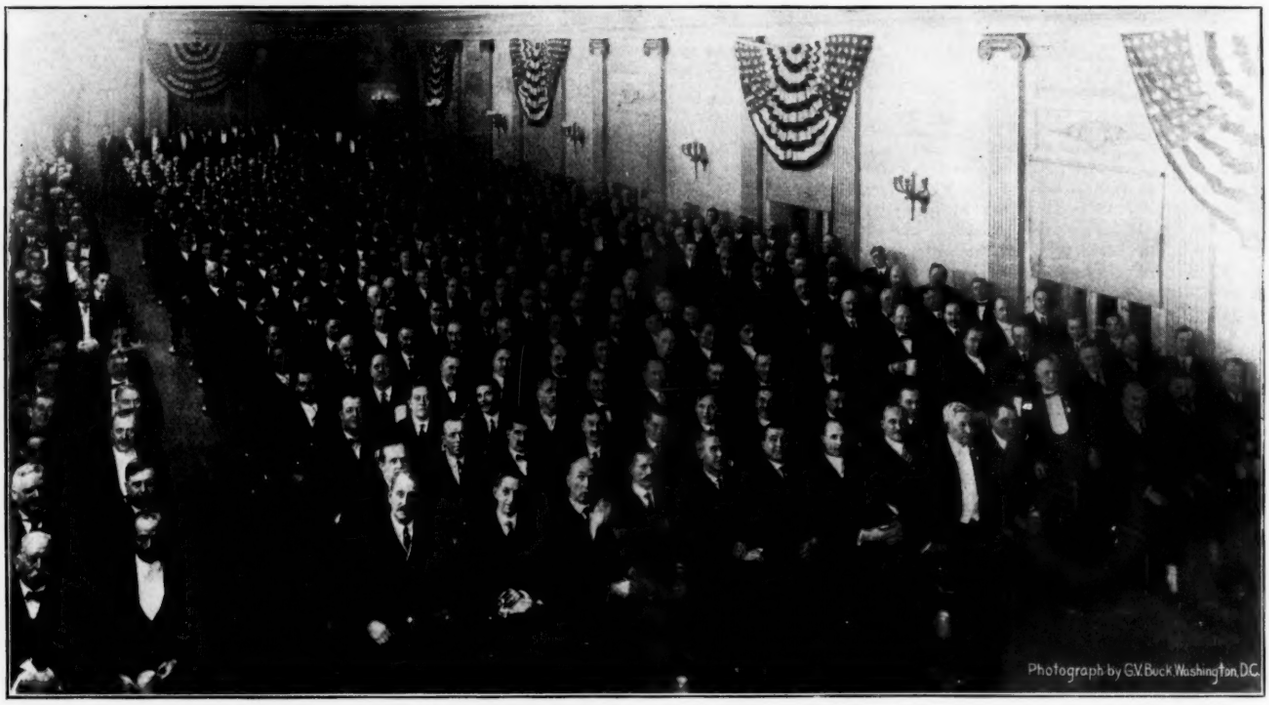
The Marine Engineers' Beneficial Association of the United States of America convened at Washington, D. C., for its forty-second annual convention during the week commencing Monday, Jan. 22. Headquarters was at the Raleigh Hotel. The attendance was unusually large, there being approximately 150 votes represented by 100 delegates. In consequence of the large amount of important business this year, the delegates were kept in almost continuous session. The report of the national treasurer finds the organization in a sound financial condition. During the afternoon session of Wednesday, Rear-Admiral Robert S. Griffin addressed the delegates.

The election of national officers at the closing of the afternoon session on Wednesday resulted as follows: William S. Brown, president; Charles S. Follett, first vice-president; William C. Wilson, second vice-president; John S. Fisher, third national vice-president; George A. Grubb, national secretary; Albert L. Jones, treasurer. The executive committee comprised Fred H. Krueger, Charles S. Follett, Paul A. Larche, William J. Du Bois and William S. Brown. The trustees of the "American Marine Engineer" are Joseph G. Myers and William H. Hyman. Past National President William F. Yates conducted the installation of officers.

The big feature of entertainment was the smoker on Thursday evening. There were about 800 in attendance including personages in the army and navy. There was a pleasing vaudeville show, and good things to smoke and drink were served at intervals. During the week there were automobile rides, shopping trips and theater parties for the ladies and guests.

The Marine Engineers' Supplymen's Association reëlected its officers as follows: George S. Norman, president; J. J. Cizek, vice-president; Charles A. Wilhoft, secretary-treasurer.

The 1918 convention of the association will be held as usual at Washington, D. C.



SMOKER OF MARINE ENGINEERS' BENEFICIAL ASSOCIATION, WASHINGTON, D. C., JAN. 25, 1917

BUSINESS NOTES

The Permutit Co. has opened a branch office in the R. A. Long Building, Kansas City, Mo., with I. E. Leininger in charge.

The Alberger Pump and Condenser Co. has opened a branch office at 1418 Pennsylvania Building, Philadelphia, Penn., with H. W. Wetjen in charge as district sales manager.

Charles Houchin Higgins, engineer-architect, announces the removal of his offices and staff from the Hudson Terminal Building to the City Investing Building, 165 Broadway, New York City.

The Homestead Valve Manufacturing Co., Inc., has appointed the following agents to represent it in their various vicinities: Seeger-Walraven Co., Atlanta, Ga.; Joplin Supply Co., Joplin, Mo.; George T. Matthews & Co., St. Louis, Mo.

The H. W. Johns-Manville Co. opened a new office at 911 Walnut St., Des Moines, Iowa, Jan. 1, thus bringing the total number of branches up to 55. William B. Roberts, who has been with this organization for a number of years, caring for the Iowa sales, has been appointed manager of the new office.

R. H. Beaumont Co., builder of conveying and hoisting machinery, has opened a New York office at 50 Church St. The office will be in charge of William P. Alexander, who has been associated with the company for many years in the capacity of field superintendent, assistant chief engineer and sales engineer.

Warren Webster & Co., of Camden, N. J., announces that it has disposed of the business of its air-conditioning department, and since Jan. 1, 1917, the Webster air-conditioning apparatus has been manufactured and exploited by the Braemer Air Conditioning Corporation, Lafayette Building, Philadelphia, Penn.

The Kennedy Valve Manufacturing Co.'s entire sales force convened at its office in Elmira, N. Y., Dec. 14-15, 1916. On the morning of the first day the entire company of salesmen and managers made a tour of inspection through the company's plant. The afternoon was spent in business discussion, and in the evening a dinner was served at the Elmira Country Club. The meeting was voted as the most successful of its kind ever held by the company.

Ophüls, Hill & McCreery have been incorporated as consulting engineers, with offices at 112-114 West 42nd St., New York. The firm comprises Fred Ophüls, the well-known ice and refrigerating engineer, in association with J. Harold McCreery, mechanical engineer. Halbert P. Hill, well known in the electrical field, will handle the mechanical and electrical problems. The firm specializes on industrial power plants and ice and refrigerating plants as well as electrical installations. A special department will be maintained for the appraisal and analysis of existing plants.

Westinghouse Air Brake and Union Switch Merger—The plan for the merger of the Union Switch and Signal Co. into the Westinghouse Air Brake Co. was formerly declared effective Jan. 12. At a special meeting of the board of directors of the Air Brake company it was announced that practically all the stock of the Union Switch and Signal Co. had been deposited in assent of the plan. Later a meeting of the directors of the Switch company was held for the purpose of reorganization and giving Air Brake officers representation on the board of directors. The officers of the company as chosen are as follows: Chairman of the board, W. D. Uptegraff, formerly president of the Union Switch and Signal Co.; president, A. L. Humphrey, first vice-president and general manager of the Air Brake company; vice-president, John F. Miller, president of the Air Brake company; vice-president and treasurer, T. W. Siemon, formerly vice-president of the Signal company; vice-president in charge of sales, G. A. Blackmore, formerly manager of sales of the Signal company; acting vice-president and secretary, T. S. Grubbs, formerly secretary of the Signal company; controller, C. A. Rowan, controller of the Air Brake company; auditor, F. V. Shannon, formerly auditor of the Signal company; assistant treasurer, M. K. Garrett, who was associated with George Westinghouse's private office in an accounting capacity for 25 years.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points are as follows:

ANTHRACITE

	Circular		Individual	
	Feb. 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago
Buckwheat	$3.60	$3.10	$6.00@6 50	$3.00@3.50
Rice	3.10	2.50	5.50@5.75	2.60@3.00
Boiler	2.95	....	5.00@5 25	.....
Barley	2.85	2.25	4.20@4.60	2.45@2.60

BITUMINOUS

Prices per gross ton for Boston delivery:

	F.o b. Mines All-Rail Rate $2.60 to Boston		Alongside Boston Water Coal	
	Feb. 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago
Clearfields	$4.50@4.25	$2.35@2.60	$8.00@8.25	$5.50@5.75
Cambrias and Somersets	4.90@5.50	2.75@3 00	8.25@8.50	.....
	F.o.b. Hampton Roads		On Cars, Boston	
	Feb. 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago
Pocahontas and New River	$6.50@6.75	$2.85	$9.00@9.25	$6.00@6.50

New York—Current quotations per gross ton f o.b. Tidewater at the lower ports are as follows:

ANTHRACITE

	Circular		Individual	
	Feb. 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago
Buckwheat	$2.75	$2 75	$6.00@6.25	$3.50@3.75
Rice	2.20	2.25	4.50@5.00	3 25@3.50
Barley	1.95	1.75	3.50@3.75	2.75@3.00

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	South Amboy		Port Reading	Mine Price	
	Feb. 3, 1917	One Year Ago	Feb 3, 1917	Feb. 3, 1917	One Year Ago
Clearfield	$6.50@6.75	$3.90@4.00	$6.50@6.75	$4.75@5.00	$2.35@3.45
South Forks	6.75@7.00	4 00@4.25	6.75@7.00	5.25@5.50	2.45@2.70
Nanty Glo	6.75@7.00	4.20@4 25	6.75@7.00	5.25@5.50	2.65@2.70
Somerset	6.50@6.75	3.75@4.00	6.50@6.75	4.25@4.50	2.20@2.70
Quemahoning	6.75@7.00	3.75@4.00	6.75@7.00	4.75@5.00	2.45@2.70

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Feb. 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago
Buckwheat	$2.00	$1.55	$2.90	$2.30
Rice	1.25	.90	2.15	1.80
Boiler	1.10	....	2.00	....
Barley	1.00	.55	1.90	1.30

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Feb. 3, 1917	One Year Ago
Slack	$4.50	$1 35@1.60
Mine-run	4.75	1.50@1.75
¾-in.	4.75	1.60@1.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b mines:

	Springfield	Clinton and Sullivan Cos.
Steam lump	$3.00@3 25	$3.00@3.50
Egg	3.25@3 50	3.25@3.75
Nut	3.00@3.50	3.00@3.50
Mine-run	3.00@3.25	3.00@3.50
Screenings	2.75@3.00	3.00@3.25

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless
Lump	$3.75@4.00	$3.75@4.00	$4.75@5.25
Egg	3 75@4.00	3.75@4.00	4.75@5.25
Nut	3.75@4 00	3.75@4.00	.....
No. 1 nut	3.75@4.00	.....	.....
No. 2 nut	3.50@3.75	.....	.....
No. 3 nut	3.25@3.50	.....	.....
No. 1 washed	3.75@4.00	.....	.....
No. 2 washed	3.25@3.50	.....	.....
Mine-run	3.25@3.50	3.25@3.50	4.50@5.00
Screenings	3.25@3.50	3.25@3.50	.....

Hocking lump, $4; splint lump, $4.

St. Louis—Price per net ton f.o.b. mine:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago	Feb. 3, 1917	One Year Ago
6-in. lump	$3.00@3.25	$1 60@1.75	$2.75@3	$1.35@1.50	$2.50	$1.15@1.25
2-in. lump	.....	1.40@1.50	.....	1 25@1.35	2.35	.95@1.15
Steam egg	.....	1.40@1.65	2.75	.....	2.35	.....
Mine-run	2.75@3.00	1.15@1.20	2.50@2 75	1.10@1.15	2.25	.90@1.15
No. 1 nut	.....	1.25@1.40	.....	.....	.....	1.00@1.25
2-in. screen.	2.75@3	.85@1 00	2.50@2.75	.75@ .85	2.35	.75@ .85
No. 2 washed	3.00@3.25	1.50@1.60	3@.325	1.35@1.50	.....	1.40@1.50

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f o.b. mines:

	Mine-Run	Washed Mine-Run	Washed Nut
Pratt	$3 00	$4.50	$4.50
Big Seam	2.50	$3.75@4.25	$3.75@4.25
Black Creek	$3.00@3.25	4.50	4.50
Carbon Hill	2.50	4.00	4.00
Cahaba	3 50	4.50	4.50

PROPOSED CONSTRUCTION

Ariz., Casa Grande—City will receive bids on Feb. 15 for an electric-light and power plant. Estimated cost, $30,000. V. A. Thompson, Phoenix, Engr.

Ark, Rogers—E. Masoner, Bentonville, and W. A. Wilson, Springdale, have submitted the proposition to the City Council to install an electric-light plant. Estimated cost, $100,000.

Iowa, Davenport—The People's Light Co. will make improvements in Davenport. Estimated cost, $50,000.

Kan., Long Island—City is having plans prepared for an electric-light plant.

Kan., Silver Lake—City is considering plans to complete electric-light plant.

Ky., Butler—C. E. Record is reported interested in a plan to install an electric-light plant in Butler.

Ky., Clay—Plans are being considered by Mitchell & Dunnigan, owners of the local electric-light plant for a transmission line from Clay to Dixon.

Ky., Jamestown—J. E. Russell and Associates are reported interested in a project to install an electric-light plant in Jamestown.

Ky., Stanton—The citizens voted favorably on the $15,000 bond issue to install an electric-light plant.

Mass., Boston—Edison Electric Illuminating Co., 30 Boylston St., has had prepared plans for a substation. Bigelow & Wadsworth, 120 Tremont St., Arch.

Mass., Brockton—Y. M. C. A. contemplates installing an electric-light plant in its building. M. A. Davis and E. B. Keith, Members of Comn.

Mass., Worcester—The Worcester Electric Light Co. is considering plans for a transmission line on Vernon, Paine, Kenilworth and Greenwood St. and Malvern Rd.

Mich., Ann Arbor—The Detroit Edison Co., 18 Washington Blvd., Detroit, will soon award the contract for a hydro-electric plant on the Huron River. Estimated cost, $140,000.

Mich., Holly—The village voted favorably on the $30,000 bonds issue to install an electric-light plant.

Minn., Badger—The City Council is considering plans to install an electric-light plant.

Minn., Shelby—City contemplates installing electric-lighting system.

Mont., Shelby—J. A. Johnson is reported interested in a plan to install electric-light plant in Shelby.

Mo., Edith—Press reports state that C. F. Robertson and associates contemplate a dam and power plant on the Niangua River near Edith, Camden County.

Mo., Festus—The Missouri Electric Co. has purchased the municipal electric-light plant and will improve and extend the system.

Mo., Warrensburg—City is considering plans to install electric-light plant.

N. H., Portsmouth—Rockingham County Light and Power Co., 29 Pleasant St., is preparing plans for an addition to its power plant. Estimated cost, $200,000. H. M. Hope, 185 Devonshire St., Boston, Engr.

N. J., Jamesburg—L. H. Saab has applied to the City Council for permission to install an electric-light plant and a distribution system in the city.

N. J. McAfee—Plans are being considered by the Bethlehem Steel Co., South Bethlehem, Penn., for a 1-story power plant.

N. Y., Binghampton—The Binghamton Light, Heat and Power Co. is considering 5 mi. of transmission line to connect its new plant and the substation.

N. Y., Eagle Bridge—The Village Council is planning to install an electric-lighting system.

N. Y., Long Beach—The Long Beach Power Co. has applied to the Public Service Commission for permission to build electric transmission lines on the property of the Estates of Long Beach and Lido Corporation.

Ohio, Akron—The Public Utilities Corporation has granted permission to the Northern Ohio Traction and Light Co. to issue $1,000,000 capital stock. The company intends to improve and extend its system.

Ont., Bala—Bala Electric Light and Power Co., incorporated with $25,000 capital stock, is planning an electric-light plant.

Ont., Chatham—The citizens voted in favor of a bylaw for $15,500 to extend the hydro-electric system.

Ont., Iriquois Falls—The Alitibi Pulp and Paper Co. contemplates a power plant.

Ore., Portland—The City Council contemplates installing an electric-light plant.

Penn., Farrell—The American Sheet and Tin Plate Co. will install an electric power and boiler house in Farrell.

Penn., Tullytown—The City Council will install an electric-light and power plant.

Que., Greenfield Park—City is considering an electric-lighting system. Estimated cost, $25,000.

Tex., Koose—The Kosse Light and Power Co. contemplates an electric-light and power plant. Estimated cost, $12,000.

Wash., Index—The City Council contemplates issuing $10,000 bonds to install an electric-light plant.

Wash., Olympia—Olympia Light and Power Co. contemplates a 1000-hp. steam auxiliary plant. Estimated cost, $40,000. F. D. Nims, Port Angeles, Asst. Gen. Mgr. and Ch. Engr.

Wis., Cudahy—Plans are being prepared for an addition to the power plant of the Federal Rubber Manufacturing Co. Estimated cost, $200,000. H. M. Hope, 185 Devonshire St., Boston, Mgr.

Prices—Materials and Supplies

ELECTRICAL SUPPLIES

Knife Switches—Following are net prices each in New York for knife switches mounted on slate base, front connected, punched clip type:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
Double pole, single throw, fuseless	$0.76	$0.88	$1.80	$3.24
Double pole, single throw, fused	.76	1 30	2 63	4.86
Double pole, double throw, fuseless	1.22	1.44	3.24	5.40
Double pole, double throw, fused	1.58	2.45	5.33	9.36
Triple pole, single throw, fuseless	1.15	1 32	2.71	4.87
Triple pole, single throw, fused	1.15	1.94	3.96	7.50
Triple pole, double throw, fuseless	1 91	2 23	4.97	8.35
Triple pole, double throw, fused	2.53	3.92	8.52	14.98

Lots $25 and more, list.

Fuses—Following are net prices in New York in standard packages:

	0-30	31-60	61-100	110-200	225-400
Fuse plugs, per 100	$4.20	....	....	....	....
Enclosed fuses, each	.1275	$0.18	$0.46	$1.02	$1.84

Standard package fuse plugs, 500; cartridge 3-60, 100; 65-100, 50; 110-400, 25. Fuse plugs less than package, 5c. each.

Sockets—Following are net prices per 100 in New York for standard packages:

	Package	Key	Keyless	Pull Chain
⅛-in. cap	500	$20 75	$18.80	$37.70
⅜-in. cap	250	28.08	25 92	47.52
Pendant cap ⅛-in.	250	20.75	18.80	37.70
Less than package in ⅛ and pendant and more than 25, each		.22	.20	.40

Cut Outs—Following are net prices in New York for standard package quantities:

		Edison Plug	Cartridge Fuse		
	Packages	0-30	0-30	31-60	61-100
Double pole, main line	50	$0.165	$0.3025	$0.77	$1.54
Triple pole, main line	50	.242	.44	1.10	2.20
Double pole, single branch	50	.176	.385	.965	...
Triple pole, single branch	50	.297	.7425	1.65	...
Double pole, double branch	25	.341	.715	1.925	...
Triple pole, double branch	25	.495	1.2375	3.30	...
Three- to two-wire, double branch	25	.352	.825	2.31	...

Copper Wire—Following are prices in New York for rubber-covered wire in standard quantities of 1,000 ft.:

	Jan. 30, 1917		
No.	Single Braid	Double Braid	Duplex
14	$13.50	$14.90	$25.56
12	17.70	19 70	38.65
10	24 30	26.75	52.70
8	34.50	37.12	73.60
6	54.05	58.55	....
5	72.10	77.60	....
4	48.80	92.40	....
3	104.10	110.00	....
2	125.00	132 00	....
1	162.00	170.50	....
0	223.00	223 00	....
00	267.50	267 50	....
000	328.00	328.00	....
0000	403.50	403.50	....

Lamps—Below are present quotations on Mazda B lamps in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0.27	$0.30	100	100	$1.00	$1.05	24
15	.27	.30	100	300	3.00	3.10	24
25	.27	.30	100	500	4.50	4.65	12
40	.27	.30	100	750	6.00	6.25	8
60	.36	.40	100	1,000	7 00	7.25	8

Standard package quantities are 10% from above prices. Yearly contracts ranging from $150 up allow a discount of 17% from list, with corresponding discounts for larger contracts.

Separable Attachment Plugs—Following are prices in New York:

Porcelains, standard package 250, each	$0.21
Composition, standard package 250, each	.28
Side outlet, cement taps, standard package 50, each	.35

Cord—Following are prices in New York in cents per foot:

	Coil, Ft.			Coil, Ft.	
No. 18 cotton, parallel	250	2.83	¼-in. loom	250	3.00
No. 16 cotton, parallel	250	3 65	⅜-in. loom	250	4 50
No. 18 cotton, reinforced	250	4.07	½-in. loom	200	6.00
No. 16 cotton, reinforced	250	4.86	⅝-in. loom	200	7.50
No. 18 canvasite	250	3.17	¾-in. loom	150	9.00
No. 16 canvasite	250	3 88	1 -in. loom	100	12.50
			1¼-in. loom	100	16 50
			1½-in. loom	100	20.00

Locknuts and Bushings—Following are net prices in New York in standard packages, which are: ½ in., 1,000; ¾ to 1¼ in., 100; 1½ to 2 in., 50:

In.	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10 25	22 50
2	10.00	16.40	30 00
2½	12.30	24.60	67.50

Conduit—Following are net prices in cents per ft. in New York in 1,000-ft. lots:

In	Rigid	Flexible	In	Rigid	Flexible
½	5.18	6.80	1½	16.22	23.80
¾	6.78	8.84	2	21.83	30.60
1	10.03	14 28	2½	34.51	35.36
1¼	13.57	17.68			

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

Conduit Couplings—Following are net prices in New York in standard packages:

	Per 100			Per 100	
In.	Rigid	Flexible	In	Rigid	Flexible
½	$4.69	$9 37	1½	$15.12	$22.50
¾	6.70	12.00	2	20.16	30 00
1	8.71	15.75	2½	28.80	45.00
1¼	12 24	15.75			

Armored Cables and Box Connectors—Following are net prices in New York per 1,000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$70.00	$4.50	$106.26	$3 75
12	103.95	4.50	130.90	3.75
10	142.45	4.50	180.95	3.75
8	180.95	4 50	250.25	3.75
6	284.90	5.70	363.44	7 00
4	442.75	8.40	....	....

Standard lengths per coil—Nos. 14 to 10, 150@250 ft.; Nos. 8 to 4, 100@150 ft.

MISCELLANEOUS

Hose

Fire

	50-Ft. Lengths
Underwriters', 2½-in.	55@60c. per ft.
Common, 2½-in	60% from list

Air

First Grade	Second Grade	Third Grade
¾-in., per ft. $0.45	$0.25	$0.18

Steam—Discounts from list

First grade..... 33⅓% Second grade..... 40% Third grade..... 50%

Rubber Belting—The following discounts from list apply to transmission rubber and duck belting:

Competition	60%	Best grade	30%
Standard	50%		

Leather Belting—Present discounts from list in New York are as follows:

Medium grade..... 40—5% Heavy grade..... 35—5%

Packing—Below are prices per pound, New York City:

Asbestos

Valve and Stuffing Box	Twisted plain, 25-lb. cartons	$0 70
	Twisted graphite, 25-lb cartons	.80
	Braided plain, 25-lb. cartons	.90
	Braided graphite, 25-lb. cartons	1 00
Asbestos wick in balls, ¼, ½, 1 lb., 25- and 50-lb. cartons		.75
Rubber asbestos, compressed sheet, medium grade, about		.80

Steam

Following in 25- and 50-lb. cartons:

First grade $0.75 Second grade $0.50

Rubber and Duck

Higher grade $0.40 Cold water $0.25

Piston

Asbestos, duck and rubber... $1.25 Rubber and duck..... $0 90
Flax first grade..... .85

Greases—Price in New York in cents per pound for barrel lots:

Cup	5@7c	Axle	3@4c.
Fiber or sponge	5@7c.	Gear	4@5c.
Transmission	5@7c.	Car journal (S & F)	6½c

Fuel Oil—Price in cents per gal. at Eastern terminals in bbl. lots:

Domestic light, 22-26 Baumé	5½@6
Mexican heavy, 12-14 Baumé	4½@5

Eastern terminals are Boston, Providence, Bayonne, Philadelphia, Baltimore and Norfolk.

Cold Drawn Steel Shafting—From warehouse to consumers requiring fair-size lots, the following quotations hold:

	Jan. 30, 1917	Six Months Ago
New York	List plus 20%	List plus 20%
Cleveland	List plus 20%	List plus 20%
Chicago	List plus 5%	List price

Fire Brick—Quotations on the different kinds are as follows, f o b works, eastern Pennsylvania:

Silica brick, per 1,000	$40.00@ 50.00
Fire clay brick, per 1,000	35.00@ 40.00
Magnesia brick, per net ton	135.00@140.00
Chrome brick, per net ton	125.00@135.00
Deadburned magnesite brick, per net ton	85.00@ 90.00
Special furnace chrome brick, per net ton	60.00@ 70.00

Standard size, 9x4½x2½ in. The second quality is $4 to $5 cheaper per ton.